Volume 10B, Number 1–3, October 1961

BULLETIN OF THE RESEARCH COUNCIL OF ISRAEL

Section B
ZOOLOGY

Bull. Res. Counc. of Israel B. Zoology

This volume is dedicated
to the memory of
PROFESSOR FRITZ SHIMON BODENHEIMER

The Weizmann Science Press of Israel • Jerusalem •

• Volume 10B, Number 1–3, October 1961

BULLETIN OF THE RESEARCH COUNCIL OF ISRAEL

Section B ZOOLOGY

Bull. Res. Counc. of Israel B. Zoology

Page

NOTICE TO CONTRIBUTORS

Contributors to the *Bulletin of the Research Council of Israel* should conform to the following recommendations of the editors of this journal in preparing manuscripts for the press.

Contributions must be original and should not have been published previously. When a paper has been accepted for publication, the author(s) may not publish it elsewhere unless permission is received from the Editor of this journal.

Papers may be submitted in English and in French.

MANUSCRIPT

General

Papers should be written as concisely as possible. MSS should be typewritten on one side only and double-spaced, with side margins not less than 2.5 cm wide. Pages, including those containing illustrations, references or tables, should be numbered.

The Editor reserves the right to return a MS to the author for retyping or any alterations. Authors should retain copies of their MS.

Spelling

Spelling should be based on the Oxford Dictionary and should be consistent throughout the paper. Geographic and proper names in particular should be checked for approved forms of spelling or transliteration.

Indications

Greek letters should be indicated in a legend preceding the MS, as well as by a pencil note in the margin on first appearance in the text.

When there is any room for confusion of symbols, they should be carefully differentiated, e.g. the letter "l" and the figure "1"; "O" and "0".

Abbreviations

Titles of journals should be abbreviated according to the *World List of Scientific Periodicals.*

Abstract

Every paper must be accompanied by a brief but comprehensive abstract. Although the length of the abstract is left to the discretion of the author, 3% of the total length of the paper is suggested.

References

In Sections A and C, and in Letters to the Editor in all Sections, references are to be cited in the text by number, e.g.... Taylor[3] ..., and are to be arranged in the order of appearance.

In Sections B, D E, and G, the references are to be cited in the text by the author's name and date of publication in parentheses, e.g. .... (Taylor 1932).... If the author's name is already mentioned in the text, then the year only appears in the parenthesis, e.g. ... found by Taylor (1932).... The references in these Sections are to be arranged in alphabetical order.

In Section F, references are to be cited in the text by number in square brackets, e.g. . . . Taylor [3]. . . , and are to be arranged in alphabetical order.

The following form should be used:

3. Taylor, G. I., 1932, *Proc. roy. Soc.*, A138, 41.

Book references should be prepared according to the following form:

4. Jackson, F., 1930, *Thermodynamics*, 4th ed., Wiley, New York.

TYPOGRAPHY

In all matters of typography, the form adopted in this issue should be followed. Particular attention should be given to position (of symbols, headings, etc.) and type specification.

ILLUSTRATIONS

Illustrations should be sent in a state suitable for direct photographic reproduction. Line drawings should be drawn in large scale with India ink on white drawing paper, bristol board, tracing paper, blue linen, or blue-lined graph paper. If the lettering cannot be drawn neatly by the author he should indicate it in pencil for the guidance of the draftsman. Possible photographic reduction should be carefully considered when lettering and in other details.

Half-tone photographs should be on glossy contrast paper.

Illustrations should be mounted on separate sheets of paper on which the caption and figure number is typed. Each drawing and photograph should be identified on the back with the author's name and figure number.

The place in which the figure is to appear should be indicated in the margin of the MS.

PROOFS

Authors making revisions in proofs will be required to bear the costs thereof. Proofs should be returned to the Editor within 24 hours; otherwise no responsibility is assumed for the corrections of the author.

REPRINTS

Reprints may be ordered at the time the proof is returned. A table designating the cost of reprints may be obtained on request.

Orders in America should be addressed to The Weizmann Science Press, P.O.B. 801, Jerusalem, or through booksellers, and in England and Europe to Wm. Dawson and Sons, Ltd., Cannon House, Macklin Street, London, W. C. 2, directly or through booksellers — Annual subscription per section (four issues): IL 6.000 ($ 6.00, £ 2.20). Single copy: IL. 1.500 ($ 1.50, 12s.) — Manuscripts should be addressed: The Editor. The Weizmann Science Press of Israel, P.O.B, 801, Jerusalem, 33 King George Ave. Telephone 26345

Professor Fritz Shimon Bodenheimer
1897–1959

PROFESSOR FRITZ SHIMON BODENHEIMER

1897–1959

rofessor Fritz Shimon Bodenheimer was one of the founders of the Bulletin of e Research Council of Israel and a member of the General Editorial Board. His ntimely passing has taken from us an active member of our board and the pioneer f our day in the research on the animal life of Israel who stood in the ranks of ristram and Aharoni.

Professor Bodenheimer was born June 6, 1897 in Cologne, Germany. He studied edicine at Frankfurt University and then zoology at the University of Bonn where e received his Ph.D. He arrived in Palestine in 1922 and founded the Department f Entomology of the Zionist Organisation's Agricultural Research Station in Tel viv. In 1928 he was invited to The Hebrew University of Jerusalem where he founded he Department of Zoology and Entomology. In 1952 he retired from the University ut continued to do a great deal of research and writing. He passed away in London n October 4, 1959.

The long list of publications of Prof. Bodenheimer including about 400 articles nd some 50 books (see Bibliography in "A Biologist in Israel", Jerusalem 1959), is itness to his versatility and extraordinary capacity for work. He dealt with nema-odes and insects, birds and mammals, and his work included taxonomy, morpho-gy and anatomy, biology, ecology, physiology and zoogeography of animal popu-tion distribution. He dealt also with economic problems—agricultural entomology, est eradication by chemicals, and research on biological warfare. He also wrote any articles in the history of science. In his collections and compilations of scatter-l information and in his researches he made effective use of the technique of other iences—botany, physics and mathematics.

Bodenheimer was the pioneer of agricultural entomology in Israel. He investigated e life history of the various pests, and in 1930, in his book "Die Schadling fauna alastinas" he compiled the wealth of detailed data of his comprehensive work. odenheimer was one of the first to recognize the importance of studying the life story of pests for forecasting their ability to propagate under given conditions. e contributed greatly to the solution of serious agricultural problems by his studies n the ecology of the desert locust, the Moroccan locust, the Levant vole, the Medi-rranean fruit fly, various species of scale insects and other pests. He wrote an impor-nt book on this subject — "Problems of Animal Ecology" (Oxford 1938) which as revised as "Animal Ecology To-day" (Holland 1958).

Today the term "biological control" is familiar, but already some 30 years ago Boden-eimer introduced into Palestine a number of parasites and predators of various plant

pests intended to attack the Mediterranean fruit fly, the apple woolly aphid, the mea bug and others. He also included insects beneficial to men — bees, silk-worms, et

Bodenheimer also introduced into Palestine the use of chemicals for the eradicatio of pests. He introduced the use of oil emulsions against scale insects and thalliu sulphate impregnated wheat seeds to combat mice and other rodents.

Already during the first years of his scientific work, Bodenheimer realized that ther was a wealth of entomological information scattered throughout the literature of a cient to modern times which had not come to the attention of scientists. He decided undertake the giant task of compiling all this information into a modern volum and the result was his important work—"Materialen zur Geschichte der Entomol gie" — published by Junk in two big volumes (Amsterdam 1927/8).

In his last years, his most important publication was "A History of Biolog (London 1958).

Professor Bodenheimer made frequent trips to many lands where he becan familiar with the endemic characteristics of these areas. In addition to his ov observations, he was able to evaluate the findings of local research workers and generalize them to universal conclusions. He published these in his many writin and was readily willing to impart to other scientists knowledge obtained from his tri

In many of the countries he visited, Bodenheimer participated in and conducted co ses and seminars, and organized entomological institutes — particularly in Turkey a Iraq. He was an honoured guest at science congresses and visiting professor in univ sities in various countries. Many scientific societies honoured him with membersh

The Government of Israel awarded him with the Israel Prize for Agriculture in 19

In Israel many students owe to Bodenheimer their basic knowledge of biolo Among his students were not only university students, but also many school teach and educated farmers. He lectured also in settlements and towns.

Just before his untimely death, the book "A Biologist in Israel" appeared summi up Bodenheimer's activities and life work. It contains not only his autobiograp but also chapters on the development of the natural sciences in Israel and abro in the first half of the twentieth century.

Bodenheimer contributed to us with his creative inspiration and imaginatio with his articles and books which are the fruits of original ideas and an extraordina capacity for work, and in that he *knowingly* did not aspire to perfection. Had followed the path of those who hesitate to appear before the public, we would ha been the losers. All biologists concerned with the problems of biology in Israel w always remember their debt to Bodenheimer.

Reprinted from
THE BULLETIN OF THE RESEARCH COUNCIL OF ISRAEL
SECTION B. ZOOLOGY
Vol. 10B October 1961 No. 1–2

LA FORMULE CHROMOSOMIQUE DE MACROTARSOMYS BASTARDI ET LE PROBLEME DES NESOMYINAE

ROBERT MATTHEY
Université de Lausanne — Laboratoire de Zoologie et d'Anatomie comparée

A la memoire de mon cher collègue,
le professeur F.S. Bodenheimer

ABSTRACT

Macrotarsomys bastardi has a diploid number of 56. At the first metaphase, the submetacentric X and the metacentric Y are linked together by a figure of chiasmatic appearance. The discussion of this cytologial description bears on the taxonomic problem of the *Nesomyinae* (Madagassian rats) which are considerd either as monophyletic (SIMPSON) or as polyphyletic (ELLERMAN).

INTRODUCTION

Le problème des Rats de Madagascar mérite d'être abordé sous l'angle de la Cytologie comparée. On sait que ce groupe, comptant sept genres, a été considéré comme une unité systématique par Major (1897), la sous-famille des *Nesomyinae*. SIMPSON (1945) accepte ce point de vue en se fondant sur l'hypothèse que le peuplement de Madagascar s'est effectué à partir d'une souche unique dont les descendants, trouvant vides de nombreuses "niches écologiques", se sont ensuite diversifiés. Il rattache les *Nesomyinae* à la famille des *Cricetidae*, celle-ci renfermant dans le système américain, outre les *Cricetinae*, les *Gerbillinae* et les *Microtinae*. *Muridae* et *Cricetidae* entrent alors dans la superfamille des *Muroidea*.

Ce point de vue a été combattu par Ellerman (1941, 49): pour le zoologiste anglais, *Cricetinae* et *Murinae* sont deux sous-familles de *Muridae*, comme les *Gerbillinae* et les *Microtinae* et la prétendue sous-famille des *Nesomyinae* groupe des formes si différentes qu'il n'y a pas de raison pour supposer que les sept genres qui la composent aient une origine commune. L'hypothèse d'un peuplement unique de Madagascar est donc très improbable et doit être rejetée.

Sur ce dernier point, je crois qu'il faut donner raison à Ellerman: dans un travail récent sur la cytologie comparée des Caméléons, j'ai rappelé (1960) que Madagascar et l'Afrique ont été, à l'Oligocène, réunis par un large pont: celui-ci a certainement duré assez longtemps pour que la Grande-Ile ait pu recevoir, à plusieurs reprises, des immigrants de souche myomorphe.

L'analyse cytologique des Rats malgaches nous apparait comme susceptible d'apporter une solution: si le groupe est monophylétique, comme SIMPSON le suppose, on peut espérer une certaine homogénéité des conditions chromosomiques dans les divers genres. Mais il est évident que, ce travail ne portant que sur une espèce,

Received September 8, 1960

il ne peut représenter qu'un premier pas dans cette étude. S'il est possible d'obten des représentants de quelques autres genres malgaches, une solution générale pourr être apportée au problème des *Nesomyinae*.

C'est au Dr. F. POTTER (Muséum national d'Histoire naturelle de Paris) que suis redevable de deux couples de *Macrotarsomys bastardi* M.E. et GRANDIDIER q me sont parvenus au mois de juillet; la spermatogénèse des deux ♂♂ était ass active à cette époque. L'étude présente est fondée sur des "squashes" confectionné à partir du testicule et de la rate, selon ma technique habituelle: prétraitement l'eau distillée de petits fragments d'organes; fixation à l'acide acétique 50%; écrase ment entre une lame albuminée et une lamelle grasse; bain d'Alcool 70° jusqu décollement des lamelles; coloration, après hydrolyse par HCl/*N* pendant 13 minut à 56°, par la fuchsine sulfureuse ou l'hémalun acide; montage au baume. Les dessin ont été établis à partir de microphotos (négatifs X 600; positifs X 1.800) agrandi deux fois et ramenées par la reproduction au grossissement de 1.800.

LES CHROMOSOMES DE *Macrotarsomys bastardi*

Divisions diploides (figure 1–7)—Les sept figures se rapportent à des mitoses sperma togoniales (figures 1–3 et 5–6), à une cinèse somatique provenant de la rate du ♂ (figur 4), enfin à une cinèse somatique de la rate chez la ♀. Le nombre de chromosom est égal à 56, ce que confirmera l'analyse des métaphases I, dotées de 28 bivalent

Notons que la figure 4, d'une fixation irréprochable, ne montre avec certitude qu 55 éléments: il est cependant possible qu'un petit chromosome soit dissimulé pa le noyau lymphocytaire égaré dans la constellation mitotique et qu'un autre peti élément soit masqué par un chromosome plus grand, désigné par une flèche. Dan la figure 6, le décompte aboutit à 55, mais, dans cette cellule en prométaphase, existe encore des vestiges de la spirale relique, ce qui donne à plusieurs grands élé ments une forme de *S*: il est possible que l'un de ces *S* représente en réalité deu *V* par hasard juxtaposés.

L'analyse précise du caryotype est très difficile et ne m'a pas permis, le matérie à disposition étant limité, de désigner les hétérochromosomes. La figure 7 (♀) do renfermer 28 paires d'homologues, mais, étant donné son caractère encore prophas que, la position des centromères est malaisée à fixer. De plus, la spiralisation méta phasique, en voie de s'instaurer, n'est pas synchrone pour tous les segments chromo somiques, ce qui ne facilite pas la reconnaissance des futurs associés synaptique Néanmoins, la sériation (figure 13) des chromosomes, à partir des figures 4 (♂) et (♀), nous permet certaines observations. Il est nécessaire d'indiquer comment ce sériations ont été établies: les chromosomes de la ♀ ont été mesurés et groupés par 2, par ordre de taille. Bras longs et courts ont été mesurés, eux aussi. Je prend alors la moyenne de ces mensurations pour les chromosomes de chaque paire c'est cette moyenne que présente le caryogramme. Chez le ♂, j'ai procédé aux mêm opérations: pour faciliter la comparaison, j'ai déterminé le coefficient (= 1, permettant d'égaler le plus grand autosome du ♂ au plus grand autosome de la

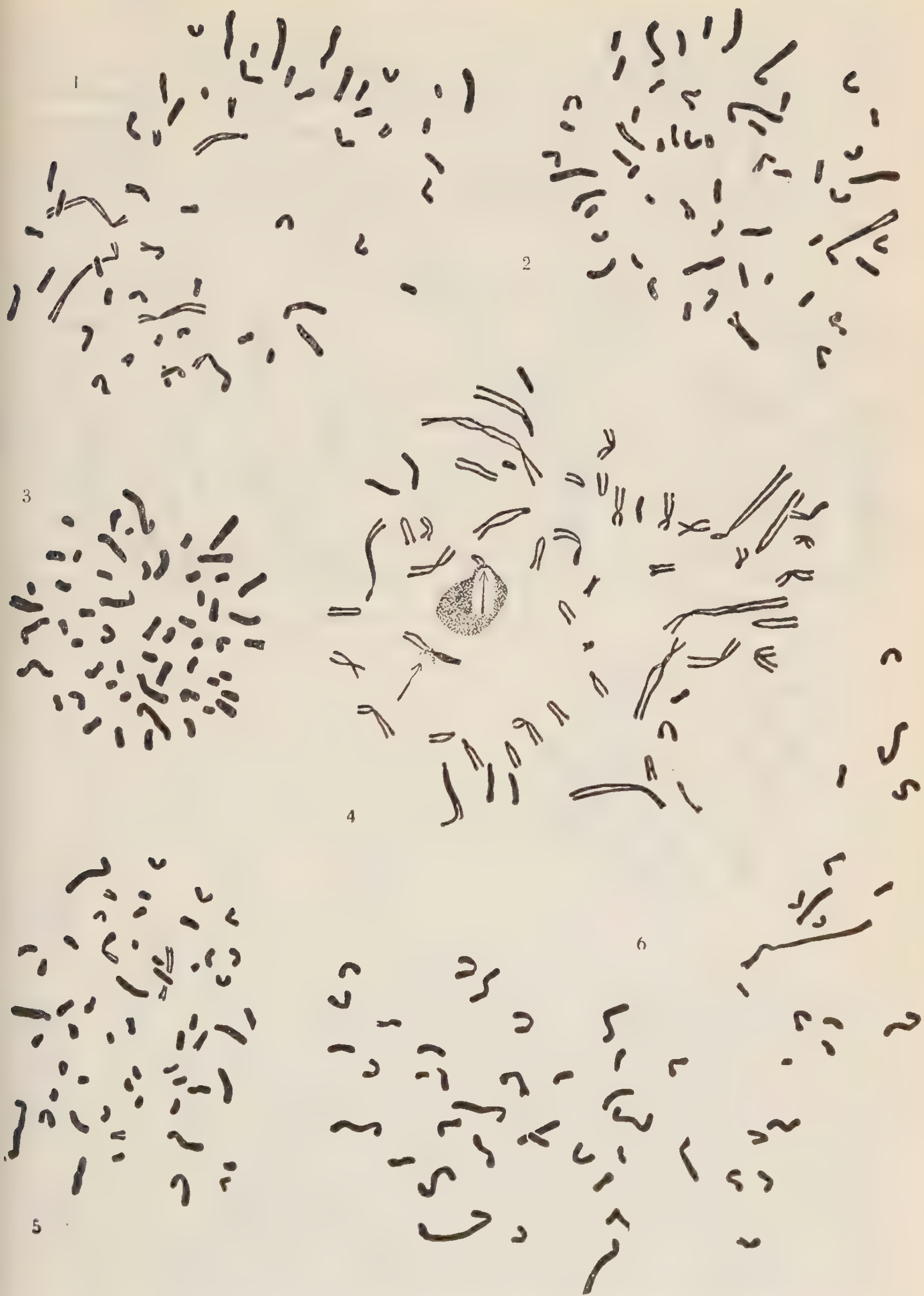


Figure 1–3 et 5–6 — Divisions spermatogoniales. Figure 4 — Division somatique dans la rate du ♂. X 1.800

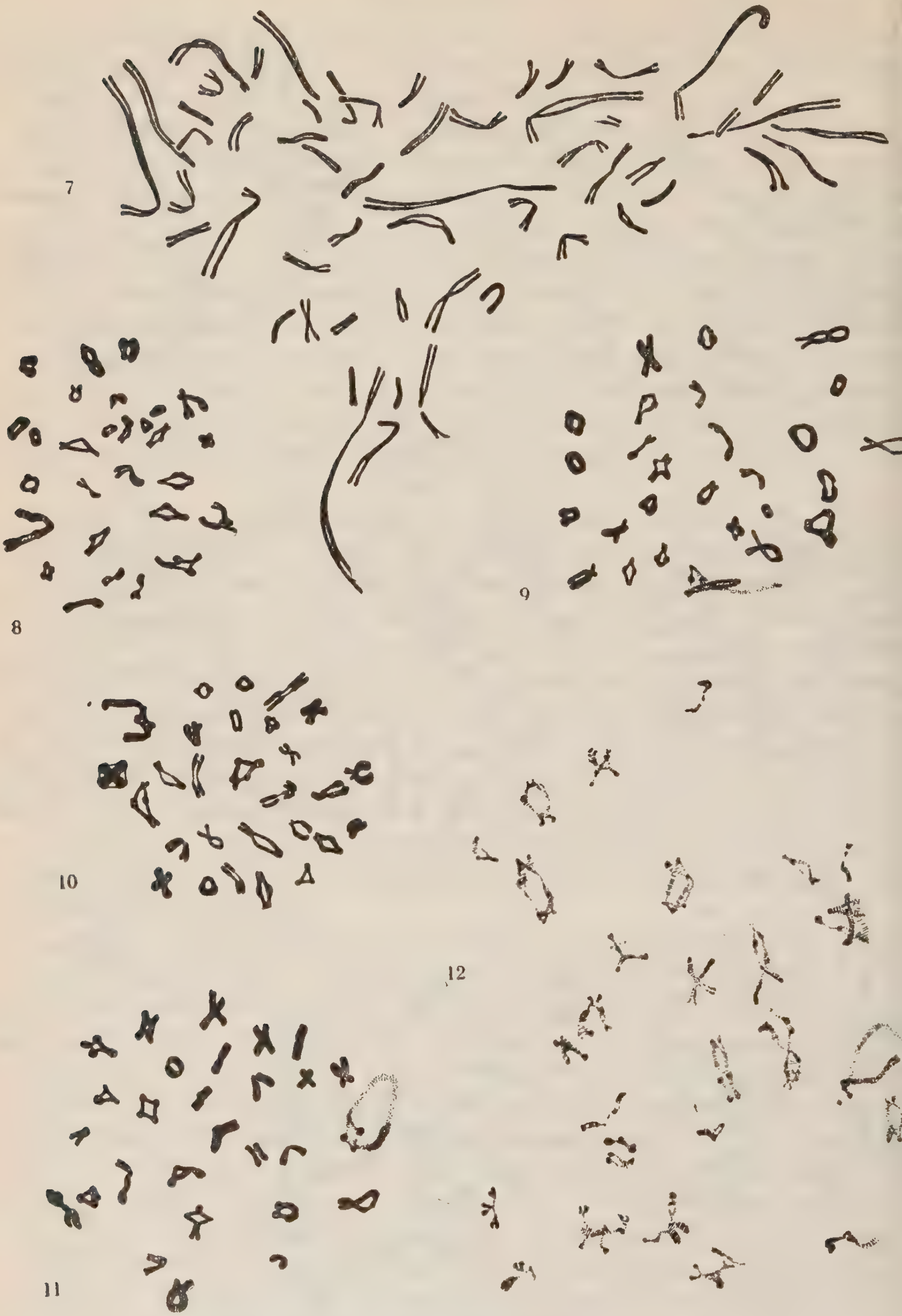
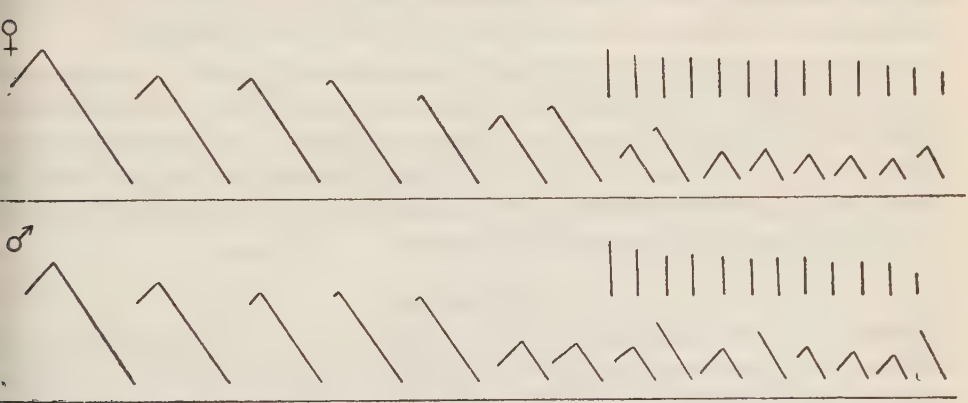


Figure 7 — Femelle: division somatique dans la rate. Figure 8–11 — Mâle: metaphases I. Figure 12 —
Diplotenie.
X 1.800

t j'ai multiplié par ce coefficient les moyennes obtenues pour chaque élément lu génome mâle. Les 12 ou 13 chromosomes les plus petits sont disposés à droite, u dessus de la série des grands éléments: leur attachement, varié, permet de les aractériser comme généralement acrocentriques, le bras court de certains d'entre ux étant cependant assez développé. Comme il n'est pas possible de fixer, chez ux, dans tous les cas, l'emplacement du centromère, j'ai représenté ces éléments ar des traits verticaux. L'examen de la figure 13 montre que les cinq paires les plus randes sont semblables dans les deux sexes et que ce n'est parmi ces couples que e trouvent les chromosomes sexuels. De la 8ème à la 15ème paire, l'accord est assez atisfaisant. Par contre, les paires 6 et 7 ne donnent pas satisfaction. Ce désaccord rovient probablement de ce que c'est à ce niveau qu'il convient de chercher les hété-ochromosomes: en effet, les métaphases I nous apprendront que l'X est un submétaentrique assez grand et l'Y un métacentrique, le bras long de l'X étant deux fois lus allongé que le bras court, lui même égal à chacun des bras de l'Y. Le classement ar ordre de taille auquel j'ai procédé et qui est correct pour la ♀, ne pourra pas 'être pour le ♂, d'où la discordance observée au niveau des paires 6 et 7.

Phases méiotiques—(figure 8–12)—Dès la pachyténie, le complexe X-Y est bien isible et se présente comme des filaments enchevêtrés, enroulés au sein d'une vacuole asophile. A la diploténie, sa structure devient claire (figure 12): deux filaments, l'un



'igure 13 — Sériation approximative des chromosomes du ♂ et de la ♀.

ong et doué d'une hétérochromatie négative manifeste, elle même liée à un manque le spiralisation, l'autre plus court et non hétérochromatique, sont unis près de eurs extrémités proximales, niveau auquel ils s'entrecroisent (chiasma?). La nature le cette association se précise à la diacinèse et surtout au début de la métaphase I figure 9 et 11): l'X et l'Y sont reliés par une figure cruciforme, d'aspect chiasmatique, t qui implique les bras courts des hétérochromosomes, le bras long de l'X conservant on hétérochromatie. Ce bras long de l'X peut être libre (figure 9) ou bien en contact troit par son extrêmité avec celle du bras de l'Y non engagée dans le chiasma. A noter que cette attraction télomérique est déjà indiquée à la diploténie (figure 12).

Vers la fin de la métaphase I (figure 8 et 10), la connexion cruciforme subsiste seul qui se résout à l'anaphase. Les métaphases II renferment 28 dyades, alors que l métaphases I montraient 28 bivalents.

DISSCUSION

Il est intéressant de retrouver chez *Macrotarsomys* des chromosomes sexuels du mêm type que chez les *Cricetinae* paléarctiques, type que j'ai décrit (1952) chez *Cricetul* *griseus* et *Cricetus cricetus*. Ce caractère tendrait donc à justifier le rattachement d *Macrotarsomys* aux Cricétinés de l'Ancien-Monde. Cependant, s'il est exact que de figures d'association *X*-*Y* aussi typiquement chiasmatiques n'ont été rencontrée que dans ce groupe, un schéma très voisin (*X* submétacentrique, *Y* métacentrique est fréquent chez les *Gerbillinae*, *Microtinae* et même chez certains *Murinae*: c'es à propos d'une espèce de cette sous-famille, *Leggada minutoides*, que j'ai ém l'hypothèse (1957) selon laquelle ce type dériverait d'une translocation de l'*X* et d l'*Y* sur une paire d'autosomes fournissant alors les centromères et les bras court d'où la possibilité que ces derniers s'associent par chiasma.

Il faut aussi rappeler que chez le seul *Cricetinae* africain, *Mystromys albicaudatu* les chromosomes sexuels sont d'un type tout différent (Matthey 1954). Enfin, à suite de l'analyse de nombreuses espèces du genre *Microtus*, j'ai montré (195 que, dans un même genre, les chromosomes sexuels pouvaient être de types si dive qu'il serait fort imprudent de tirer de leur étude des critères d'affinités.

Le nombre diploide ($2N = 56$) place *Macrotarsomys* à la limite supérieure de fréquences modales (Matthey, 1958) et, s'il est permis de prendre en consideratio l'hétérogénéité de son caryotype, c'est, parmi les *Cricetinae*, aux *Mesocricetus* qu ressemblerait le plus. Mais, comme je l'ai dit dans l'introduction, le problème de *Nesomyinae* — groupe monophylétique ou polyphylétique? — ne pourra être abord qu'après l'étude de plusieurs genres malgaches.

CONCLUSIONS

Macrotarsomys bastardi possède 56 chromosomes. L'*X* est submétacentrique, l' métacentrique. A la métaphase I, ces hétérochromosomes sont unis par une figur d'aspect chiasmatique. Cette formule est discutée en fonction du problème qu posent les Rats malgaches, considérés tantôt comme provenant d'une souche uniqu (Simpson), tantôt comme un groupement hétérogène (Ellerman).

AUTEURS CITES

1. Ellerman, J. R., 1941–49, *The families and genera of living Rodents*, *Trust. Brit. Mus. Londo*
2. Major, C. I. F., 1897, *Proc. Zool. Soc. London*, 695.
3. Matthey, R., 1952, *Chromosoma*, **5**, 113. — 1954, *Caryologia*, **6**, 1. — 1957, *Revue suisse Zoo* **64**, 39. — 1957, *Experientia*, **13**, 341. — 1958, *Arch. J. Klauss. Stift Vererbungsforsch.*, **33**, 25
4. Simpson, G. G., 1954, *Bull. Amer. Mus. Nat. Hist.*, **85**, 1.

'PROTEUS", A NEW COLOUR GENE IN BANK VOLES *CLETHRIONOMYS* TILESIUS (MAMMALIA: RODENTIA)

K. Zimmermann

The Mammal Department of the Zoological Institute and the Zoological Museum, The Humboldt University, Berlin

Results of the Chinese-German Biological Expedition 1956, Nr 11

ABSTRACT

A new dominant gene, "proteus" (Pr), was extracted from the Manchurian Bank Vole, *Clethrionomys rutilus amurensis*, Schrenk. It produces a black colouration of the upper side of the animal. The expression of proteus differs from all other darkening-factors known in mammals by a fading of the black colour with advancing age. In the last stage the pale sepia-brown black may be even lighter than in the normal form. The change from the darker to the lighter colour phases takes place during the hair moult. The rate of change is delayed in homozygotes for proteus in comparison with heterozygotes. From the concentration of the proteus gene in natural populations of *Cl. rutilus* in North Canada, and in *Cl. gapperi* in Labrador, it may be concluded that proteus has a higher selective value in a highly humid Arctic climate. In *Cl. gapperi proteus* (Bangs) from Labrador, the proteus coloration is more frequent than the normal coloration.

This contribution to the problem of mutations in natural populations is dedicated o the memory of my late friend Professor Bodenheimer who encouraged further tudies in this field (*Animal Ecology Today* 1958). The work reported here was arried out with the aid of the German Academy of Sciences, which enabled me to ake part in an expedition to northern China. Professor T.H. Shaw of Peking, supplied ne with living Northern Bank Voles from the little Chingan Mountains. A research rant from the Zoological Museum of the Humboldt University made it possible o keep living rodents. Dr. J. Wahrman of Jerusalem helped in the translation of this aper into English. To all, my sincere thanks are due.

Four pairs of *Clethrionomys rutilus amurensis* Schrenk from Manchuria, which brought to Berlin in the autumn of 1956 formed the starting material for this study. Dorsally the animals were red-brown except for one female which was yellow-rown. Among the progeny of this female were young which were dorsally black. At first thought that both parents were heterozygous for the recessive allele "black and an" belonging to the agouti series, and known from the European Bank Vole, *Clethrionomys glareolus* (Zimmermann 1937). But it soon became evident that we re dealing here with a mutation which is in some respects similar to the gene "um-rous" (U) of the House mouse, *Mus musculus*. House mice of the genetic constitu-ion Uu have a dorsal colour moderately darker in comparison with the normal gouti colour whereas animals of type UU are very dark. Homozygotes for U are

almost black on the upper side of the head and on the back (Grüneberg 1952). Gene which are probably homologous to U were described in two further mammals the factor "Steel Gray, E^D" in the domestic rabbit (Castle 1930), and an umbrou gene in the Field mouse, *Apodemus sylvaticus* (Zimmerman 1956). The present pap is concerned with the differences in expression between the umbrous gene and th new gene for darkening in Bank voles.

Material

Eight generations of *Clethrionomys rutilus* were bred from January 1957 t August 1960. Altogether 369 litters comprising 1542 young were born. The rang of litter size was between 1 and 10, (mean 4.18). Unfortunately the original fertilit and vigour of this strain were not maintained. Sterility, still-births and mortalit increased and the mean litter size decreased. The last mentioned value was 4.96 fo the first 50 litters in 1957, while it was only 3.78 for the last 50 litters in 1960. Th decrease in vigour can apparently be accounted for by a viral lung infection preser in this strain which causes weakness or death especially during winter, particular in pregnant females and in young still in the nest. The susceptibility to this infectio varies individually, as some animals have preserved their full original vigour.

Altogether 134 "black" *Cl. rutilus* were bred. From crosses between black heter zygotes and normals 64 black and 60 normal animals were obtained. This resu clearly points to a dominant mutation. It is impossible to distinguish phenotypical between homozygous and heterozygous "black" animals. Only a small number animals had a number of descendants large enough for demonstrating their hom zygosity. It is therefore necessary to combine the results of all "black" × "black crosses disregarding the constitution of the parents. Out of 25 such crosses, 70 blac and 9 normal animals were obtained. These numbers indicate that both homozygo and heterozygous parents were involved.

The reason why the original female from Manchuria was not recognized as posses ing this dominant mutation became obvious as the black young born in Berlin we observed during growth. The dorsal side of the head and the back is black whe they stay in the nest and are in their first subadult coat. At every further mou however, the amount of black pigment decreases in these regions. The origin black dorsal colouration may thus be reduced until in the last stage a light sepi brown colour is attained. Such faded animals are paler dorsally than normal re brown individuals.

The variability of the colour of the dorsal side of the head and back was determine in 85 "proteus" animals, either living or skins, according to the following six colo grades (terminology of Ridgway 1912):

Grade I	Blackish Brown (2) XLV
Grade II	As I but with irregular patches of Snuff Brown and Bister XXIX
Grade III	Bone Brown XL to Bister XXIX
Grade IV	Bister XXIX

Plate 1
Two Northern bank-voles, *Clethrionomys rulilus* Pall. from Munchuria.
Above — normal coloration.
Below — with the proteus gene.

Plate 2
From left to right 6 colour-grades (see text) of the proteus gere; on the outermost right: abnormal moulting from grade I to grade VI

Grade V Bister XXIX to Natal Brown XL
Grade VI Natal Brown to Army Brown XL

TABLE I

Colour grades (see text) of C. rutilus *possessing the proteus gene in relation to age and genetic constitution*

Colour grade	n	Mean age in months and range	Number of Tested heterozygotes	Number of Probable homozygotes	Percentage of of probable homozygotes
I	6	9.7 (3–16)	2	8	76
II	11	10.1 (7–15)	3	8	
III	16	7.8 (2–19)	10	6	
IV	18	9.2 (5–16)	11	7	
V	21	10.6 (3–22)	15	6	25
VI	7	11.1 (8–13)	6	1	

The direction of colour change is always from dark to light. The rate of this colour change and the colour attained at the end-stage differ, however, from one specimen to another. It was difficult to decide whether the rate of fading was different in homozygotes and heterozygotes, because of the lack of phenotypic differences between these two classes. Table I supplies indirect information on this question*. There is no clear correlation between age and grade of colour. Animals which were 16 months old belonged to the darkest grade I, while a young, of only 3 months, had to be classified in the second lightest group V. But if the ratios of the positively heterozygotes to the probable homozygotes are examined separately for every colour grade, a clear preponderance of the probably homozygotes is evident in the darkest grades I and II, and a clear excess of the positively heterozygotes in the lightest grades V and VI. (Probable homozygotes in I + II are 76%, and in V + VI, 25%). This means that the fading process proceeds more slowly in the homozygotes than in the heterozygotes. From two animals which must have been homozygous, judging from their progeny, one still belonged to the darkest grade I at the age of 6 months; and the other to grade III at the age of 15 months.

* Animals under two months are not included in Table I since both homozygotes and heterozygotes are similarly black at this age.

In addition to the genetic constitution the general condition of the animal may als influence the rate of fading. This conclusion is made likely by the observation of tw sick young which moulted at the ages of 1.5 and 3 months directly from black to th lightest grades V and VI. It should however be emphazised that the gene for dar colour does not reduce vitality.

No similar case of diminishing intensity of the colour of a black mutant has, to m knowledge, been described in any mammal. I designate the new gene "proteus" (Pr because O. Bangs, already in 1897, gave the name *proteus* to a subspecies of the Ame rican Bank Vole *Clethrionomys gapperi* which he discovered in Labrador on account o its colour variability. The colour table of Bangs, depicting a black animal and three bri ghter grades, represents accurately the colour of the proteus animals of ou *rutilus* strain.

The genes umbrous and proteus are alike in that both are dominant and brin about a black colouration of the dorsal side which is expressed intensely especiall in the homozygous state. Both genes have an increased selective value under certai climatic conditions. On the other band the two genes differ in the followin point:

The colour of umbrous animals does not change with age, whereas proteu animals become paler.

In the genera Mus, Apodemus and Clethrionomys two groups of darkening-gene can be distinguished with reference to their appearance in natural populations: 1. Th recessive alleles of the agouti series, *a* (entirely black) and *a/t* (black with light belly which are known only from single animals. The frequency of these genes in natur populations is never high, although the black-and-tan allele of *Cl. glareolus* is no rare in certain regions. I obtained it from 6 different populations in the area o Bandenburg. In *Apodemus sylvaticus* Niethammer (1959) found black-and-ta animals in a garden in Bonn. But even in this isolated micropopulation the frequenc of homozygotes for *a/t* was only 5%. 2. The two dominant darkening-genes, umbrou and proteus, possess an increased selective value under certain environmental cond tions and can therefore attain a high frequency in nature.

The proteus female which I brought by chance from Manchuria apparently supplie the first demonstration of this gene for a palaearctic population of *Clethrionom rutilus*. Ognev (1950) described the colour of 2388 *rutilus* from the whole territor of the USSR; 642 specimens were used for the description of *rutilus* from Manchur by the Members of the Zoological Institute of the Academia Sinica (1958), and som 400 *rutilus* were collected by the German-Chinese Expedition of 1956. Not a sing black animal was found among these more than 3000 palaearctic specimens. On th other hand, blackening of the back is known in nearctic *rutilus* from Alaska an Canada. The proteus form can be distinctly recognized in two specimens from Canad depicted on the colour photograph of Manning (1956). In one animal the middle o the back is brown-black and in the other, it is sepia (Bister XXIX). The animals a from Aklavik and Tuktoyaktuk, both in north-western Canada north of the Arct

Circle. Manning could not know the range of variability of the proteus character. t is therefore impossible to calculate with certainty the fraction of proteus animals n the populations of northern Canada on the basis of his classification into 6 colour rades which also includes normal colouration. 20% of the material is included in Manning's grades 6 ("Bister") and 5 ("Bister"-like), but it is likely that some proteus nimals were also included in grade 4. We are better informed on the distribution of he proteus gene in the American Bank Vole, *Cl. gapperi.* As was mentioned above here can be no doubt from the colour table of Bangs that the proteus gene is present lso in Labrador. On its distribution Miller (1897) says:

> "Throughout the southern part of the animal's range the red phase dominates to the nearly complete exclusion of the brown. The brown phase becomes conspicuous in the lower edge of the Hudsonian zone, and at the northernmost point from which I have seen specimens (Hamilton Inlet, Labrador) it greatly outnumbers the red."

More detailed information about the distribution of *Cl. gapperi* proteus is ecently given by F. Harper (1961). The author characterises the area of proteus as ighly humid, not only by more precipitation but by greater prevalence of fog too: 'Higher humidity in the coastal areas may have been a factor in the evolution of some of the darker subspecies" (F. Harper 1961). The supposed positive selective alue of the proteus gene in areas with increased humidity is in agreement with our knowledge of the relation between humidity and darkening factors in other nammals (Barber 1954, Zimmermann 1956).

REFERENCES

1. Bangs, O., 1897, On a small collection of mammals from Hamilton Inlet, Labrador, *Proc. Biol. Soc. Washington*, **XI**.
2. Barber, H. N., 1954, Genetic polymorphism in the rabbit in Tasmania, *Nature*, **173**.
3. Bodenheimer, F.S., 1958, *Animal Ecology to-day*, F. Junk, Den Haag.
4. Castle, W.E., 1930, *The Genetics of domestic rabbits, Cambridge.*
5. Grüneberg, H., 1952, *The Genetics of the mouse*, 2nd edition Martinus Mishoff, The Hague.
6. Harper, F., 1961, Land and fresh-water mammals of the Ungava Peninsula, *Univ. of Kansas Mus. of Nat. Hist. Lawrence, Kansas.*
7. Manning, T.H., 1956, The northern red-backed mouse, *Clethrionomys rutilus* (Pall.) in Canada, *Bull. Nat. Mus. Canada, Biol. Ser.*, **49**, 144.
8. Miller, G.S., 1897, Notes on the mammals of Ontario, *Proc. Boston Soc. Nat. Hist.*, **28, 1**.
9. Neuhäuser, G., 1936, Die Muriden von Kleinasien, *Zeitschr. f. Säugetierkunde*, **11**, 2.
0. Niethammer, J., 1959, Eine neue Farbmutante der Waldmaus, *Apodemus sylvaticus*, Säugetierkundl, Mitt. **VII**, 4.
1. Ridgway, R., 1912, *Color standards and color nomenclature.* Published by the author. Washington D.C.
2. Zimmermann, K., 1937, Die märkische Rötelmaus, Analyse einer Population, Märkische Tierwelt, 3, **1**.
3. Zimmermann, K, 1949, Zur Kenntnis der mitteleuropäischen Hausmäuse, *Zool. Jahrb. Syst Oek. Georg.*, **78**, (3).
4. Zimmermann, K., 1956, Der Umrbous-Faktor bei der Waldmaus. ibidem **84**, (4/5).
5. Zoological Institute of the Academia Sinica, 1958, *Mammals of Manchuria*, Pekin. (Chinese, English Summ.)

Reprinted from
THE BULLETIN OF THE RESEARCH COUNCIL OF ISRAEL
SECTION B. ZOOLOGY
Vol. 10B October 1961 No. 1–

THE DYNAMICS OF BIOLOGICAL PROCESSES IN LAKE TIBERIAS

A. YASHOUV AND M. ALHUNIS
Fishculture Research Station, Dor, Israel

ABSTRACT

The dynamics of biological processes in Lake Tiberias are described on the basis of weekl collected data on plankton, primary production and nutrient salts in the Bay of Beith Yera during May 1956 – July 1957. Frequent and abrupt changes in Nitrogen and Phosphoru salts, rapid variations in plankton abundance, sharp changes in oxygen consumptio rate and primary production indicate intensive and speedy biological processes which ar like a series of rapid pulsations. From the end of winter to early spring is regarded a the main period of surplus production of organic matter in the Lake.

INTRODUCTION

During 1952–1956, a limnological survey was carried out in Lake Tiberias. Sample for this survey were obtained at intervals of two weeks to one month.

Study of these samples has raised some doubt whether the frequency of samplin was such as to provide a complete picture of the dynamics of biological processes the lake. For technical reasons, and owing to lack of proper facilities the projecte sampling of the lake as a whole at weekly intervals was discontinued. Instead w confined ourselves to the collection of weekly samples from a single locality in a litt bay off Beit Yerah.

This bay, though it hardly deserves the name is a tiny gulf at the southwester shore of Lake Tiberias not far from the outlet of the Jordan. Towards the south it i protected by a small promontory and by clumps of *Phraagmites*; it is open in the eas and southeast. Consequently, there is a constant exchange of water between the lak and the bay. In undertaking the collection of weekly samples in the bay we assume that the samples thus obtained will, upon analysis, fully reflect the true nature of th dynamics of biological processes in the lake and at the same time facilitating th understanding and interpretation of data obtained from samples collecte elsewhere in the lake at monthly or fortnightly intervals.

METHODS AND EXTENT OF STUDY

Each week at a fixed hour between 9 and 10 a.m. samples were collected 150m from th shore on the 5m depth line. Samples of water and plankton were taken from the surfac and from close to the bottom. At 5m depth the following measurements were the made:

1. Oxygen, determined by Winkler's method.
2. Ammonia nitrogen, determined by direct nesslerization.
3. Nitrate nitrogen, determined by reduction method.
4. Phosphorus, by the colorimetric stannous chloride method.
5. Chlorine, by Mohr's method.

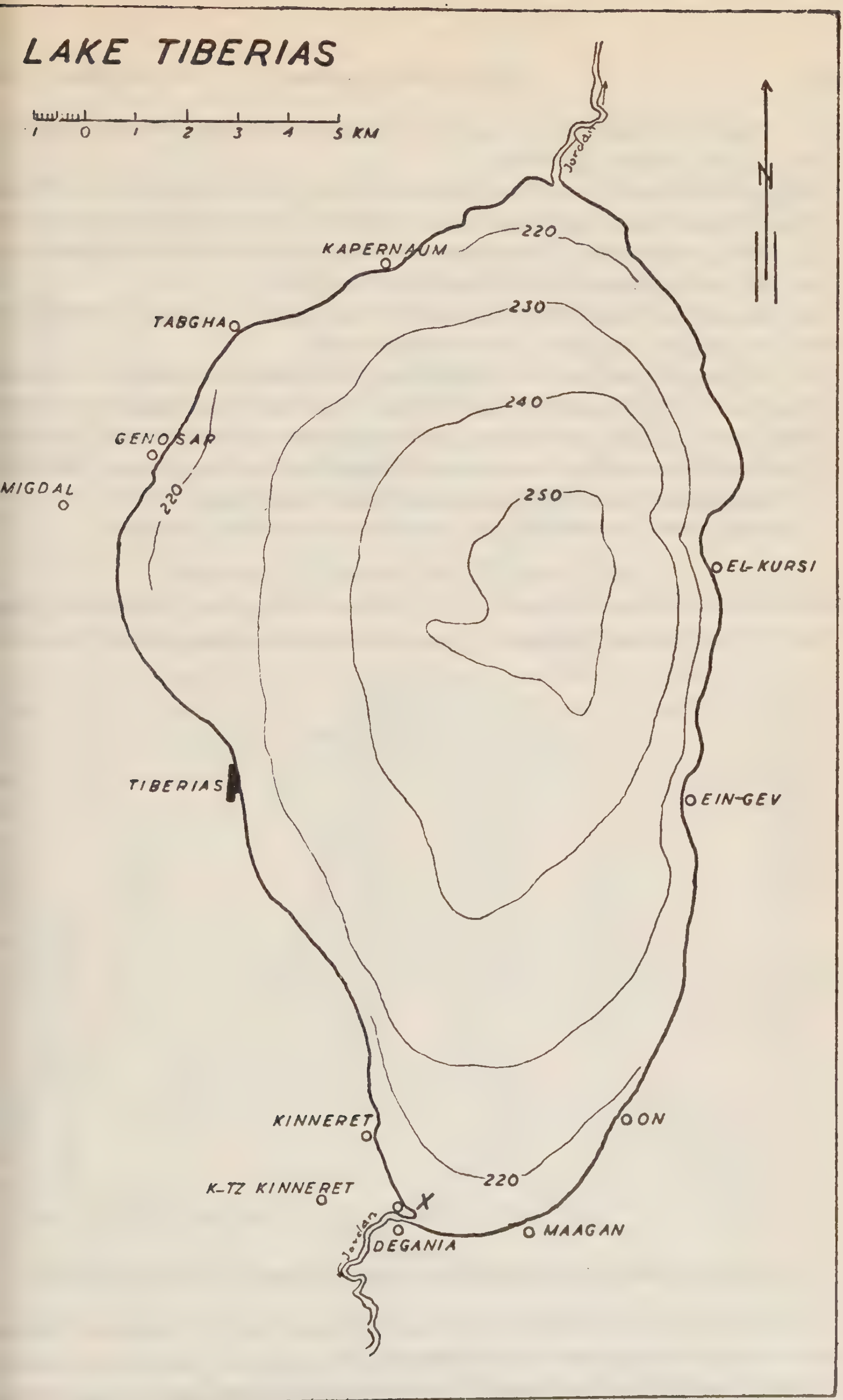


Figure 1
Map of Lake of Tiberias showing the position of the sampling station at Beit Yerah.

6. Na,K,Ca, determined by means of a flame photometer (Evans Electrosel nium Ltd.) at irregular intervals.

'Standard Methods for the Examination of Water Sewage and Industrial Waste published by the American Health Assoc. (10th ed., 1955) was followed in all tes

7. Water temperature at the surface and at the bottom. Surface temperature the water was again measured 4 hours after sampling.

8. Intensity of assimilation and rate of production of organic material we estimated using the light and dark bottles method.

9. Samples of plankton were taken from the surface by straining 50 l of wat through a No. 20 phosphor bronze net, and from the whole column of water hauling vertically a No. 20 plankton net from the bottom to the surface. The volur of plankton in the samples was measured. Zooplankton was in most cases determin to the specific level; phytoplankton in some cases to the genus.

Further details on methods are provided in the relevant chapters.

THE NATURE OF THE BIOLOGICAL PROCESSES

The variations observed in the amount of plankton, nitrogen and phosphorus (Figu 2) are both abrupt and frequent. There are as many as seven peaks in the amou

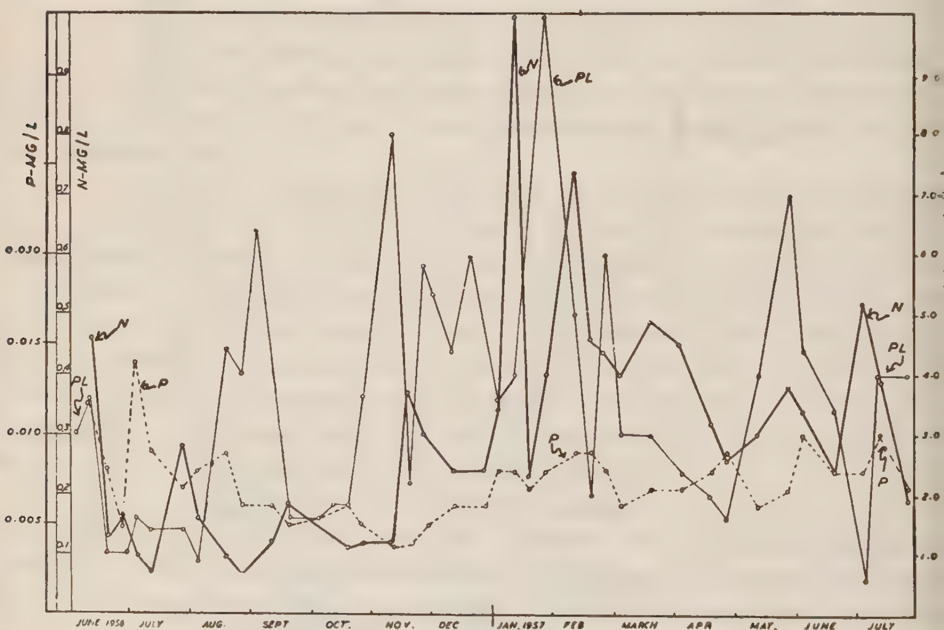


Figure 2
Seasonal variations of inorganic Phosphorus (P), Nitrogen (N) and Plankton (Pl.)

of net plankton with individual peaks mostly lasting but 2–3 weeks and follow by an abrupt decrease. Periods with low plankton mass have been more continuou generally lasting from 4 to 6 weeks. Similar variations were found in the nitrog

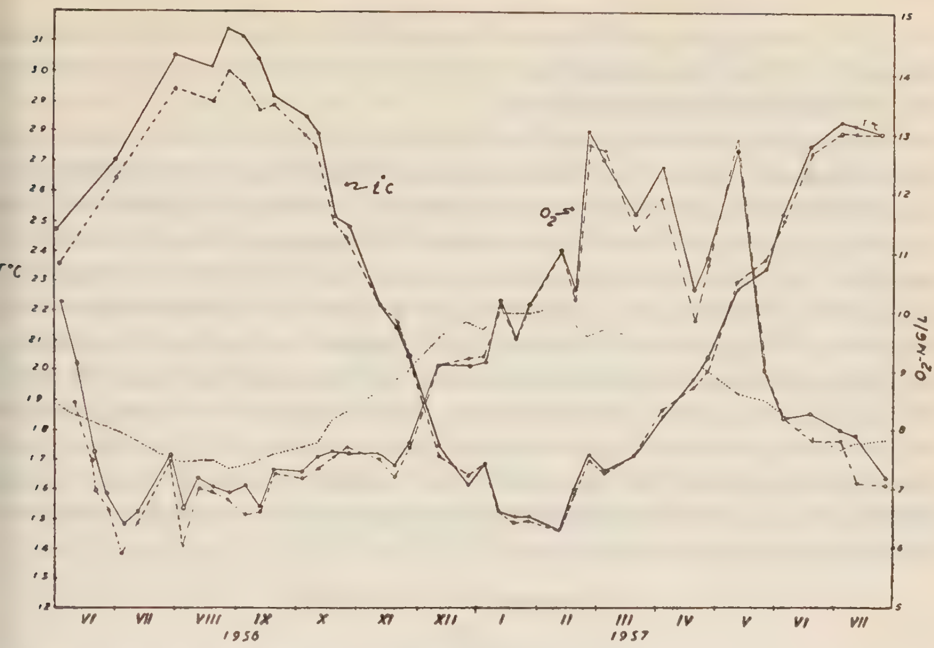


Figure 3

ırface temperature and oxygen content (solid line) at 5m depth (dashed line) and 100% oxygen saturation at corresponding temperatures (dotted line)

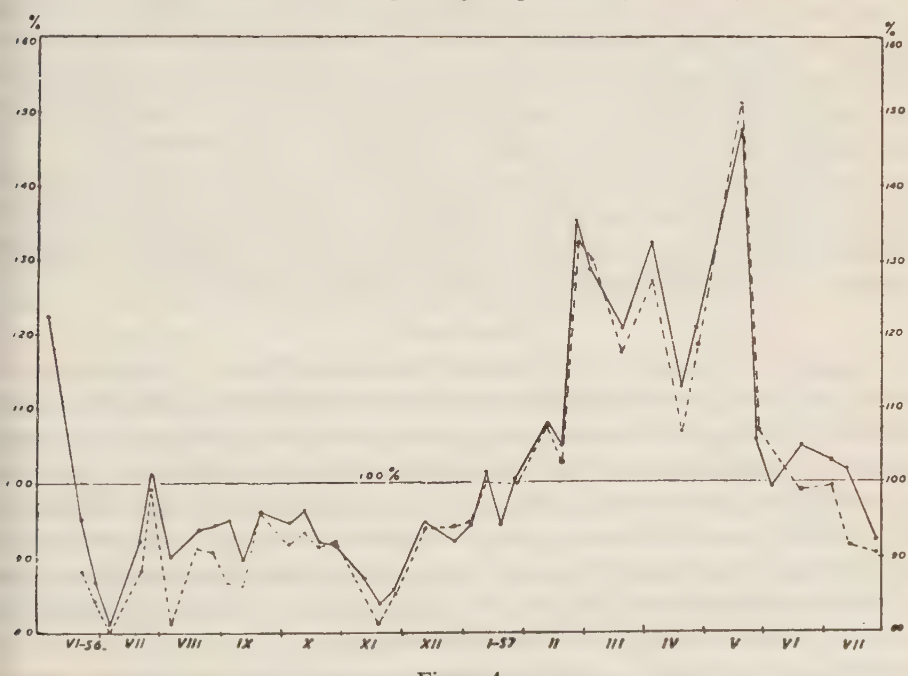


Figure 4

Seasonal variations of the oxygen saturation; surface — solid line, 5m depth — dashed line (100% saturation).

and phosphorus curves as well as in the curve for per cent of oxygen saturati (Figures 3,4). Extreme variations occur both in summer, with high temperatur and in winter with low temperatures.

The disappearance and regeneration of nutritional elements and relative oxyg saturation are the result of biological processes. Other factors reflecting these proc ses are the quantitative variations in the plankton biomass, the qualitative chang in its composition and the rapidity at which these changes occur in the lake. T results of the present investigation do not agree with the conclusion suggested Komarovsky (1959) that in Lake Tiberias, as in lakes of the temperate zone, the occur two annual peaks in the production of plankton. In fact both the quantity the plankton biomass and its composition show changes which are more like a seri of rapid pulsations which provide evidence of the intensity of biological process In other words, these pulsations reflect the rapid adaptation of the plankton to t changing environment. The high intensity of biological processes is such, that t potentialities of any new environmental conditions are very rapidly exploited to t full, with a very short lag indeed.

ENVIRONMENTAL CONDITIONS

Wind

The Beit Yerah bay is protected in the north and southwest by the high coast a by a growth of *Phragmites communis*. Consequently, the direct influence of the we erly and southwesterly winds which regularly blow in the early afternoon (throu out summer) is not very pronounced. However, currents produced by this wind e of the bay spread and thus indirectly involve the bay in the diurnal wind regi of the lake. The easterly wind — most prevalent in winter and the transitional mont of autumn and spring — whips up high waves even in the southern part of t lake, where it is narrower than further north. These waves break with much for on the western shore and inundate it. As a result of wind action there is a consta exchange of water between the lake and the bay, though in calm periods tempora differences may prevail between the water of the lake and the bay.

Temperatures

The temperature regime of the water is illustrated in Figure 3. Temperature ris until August. From April to August the lake-surface temperature may rise so rapid that in the morning there may appear a gradient of up to 2°C between the temper ture of the surface-layer and the bottom-layer of the bay, at 5m depth. As point out above, the currents produced during the day reduce or eliminate this gradier During these months air temperature, as measured in a standard meteorologic screen at Beit Yerah about 15m above lake level, is higher than the surface temp rature of the lake.(However, temperature measured in the screen is not identic with air temperature close to the surface of the lake).

Water temperature shown on the curve was measured in the late morning, betwe 0930–1030 hrs. Further measurements have shown surface temperature to rise slow

til early afternoon, when the onset of winds prevents any further rise. Maximum nperatures are 1°–1.5° C above those shown in the curve. The highest surface nperature measured in the bay was 32°C. The daily range of surface temperature es not exceed 1.5°C. The strong heating of the shore and the air leads to production of a marked gradient between surface temperature near the shore d in off-shore parts of the lake. However, once the temperature of the air begins fall, there is a rapid cooling of the surface water. This rapid cooling in September due to loss of heat to the air and to the mixing of water near the shore with the ter of lower layers. As a result, the differences between the surface temperature d the temperature at 5m disappear from October to the middle of December, and this time there is cooling of the surface layer. Also, there is constant mixing by sinking of cool water and the rising of warm water from below. The lowest ter temperature, between 14.5–15.5°C, is in most cases recorded in the second rt of January. Beginning with the end of February, a steady warming of the water kes place, in parallel with that observed in the atmosphere. It is at least in part due to prevalence of winds mixing the water. In different years heating may be more or less pid than in the curve for 1956–57.

Oxygen regime

The oxygen regime of the water is shown in Figures 3 and 4. It is evident that the ygen content of the water neaver reached minimal values even near the bottom, 5m. The absolute minimum recorded, at the beginning of July, was 5.9 mg/l, close the bottom. From then on the absolute amount of oxygen in the water increased spite of the rising temperatures. This process is due to biological activity in the ke. A more illuminating presentation of the oxygen regime is provided by data oxygen saturation of the water (Figure 4). The lowest saturation, between 80–86%, curred several times at the depth of 5m, for short periods in July, August, September d November. Highest saturation values, above 130–150%, were observed in bruary, April and May. A more detailed discussion of the variations in the oxygen ntent of the water is included in the chapter dealing with the production of organic atter in the lake.

Nutrient salts — nitrogen and phosphorus

The cycle of these salts in the water of Beit Yerah is shown in Figure 5. This warrants number of important conclusions. First, nitrogen and phosphorus never completely sappear. The lowest amount of nitrogen (NO_3+NH_4), 0.06 mg/1, was recorded ice, in the middle of July and again at the end of August, but prevailed for only very short time. The lowest amount of phosphorus, 0.004 mg/1 (P) occurred in ly 3 instances; in October and November. The second salient feature of the curve ncerns the fact that the rise and fall of these elements is not synchronous. Thus, llowing its minimum at the end of June 1956, phosphorus increases, and at the ginning of July it reaches peak value of 0.014 mg/l at the surface and 0.011 mg/l 5m. The rise in nitrogen lags some two weeks behind this. Beginning with July

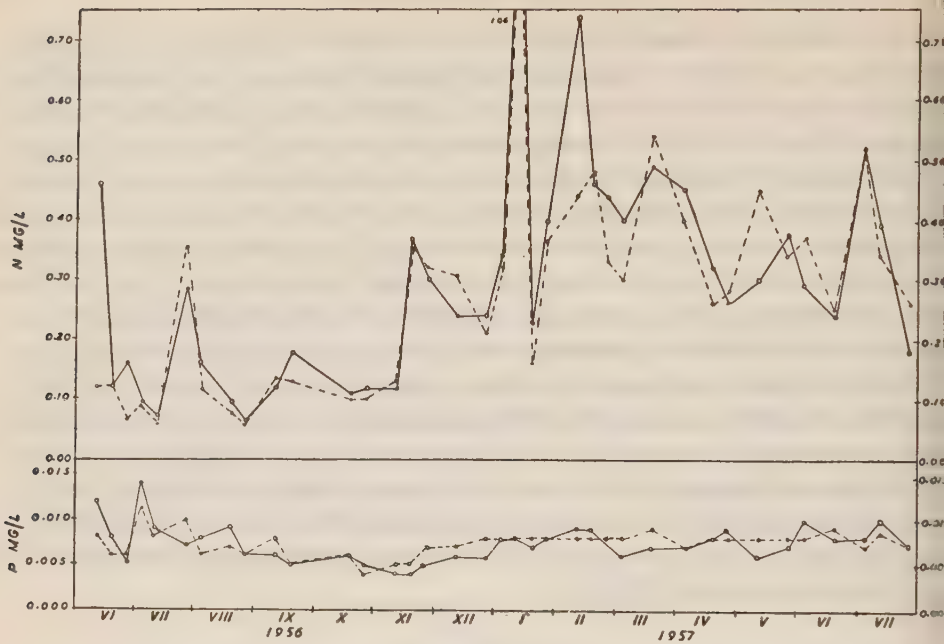


Figure 5
Seasonal variations of the nutrient salts Nitogen (N) and Phosphorus (P); surface — solid lin
5m depth — dashed line.

phosphorus concentration decreases continuously, though with frequent pulsation to attain its seasonal minimum at the end of October. This prevails in Novembe too, and from then on there is an almost regular increase in phosphorus to the middl of February. The replenishment of phosphorus near the bottom precedes that nea the surface.

The variations in nitrogen content are different. Following the peak values o June, there is a decrease and a continuously low value persists to the end of July At this time there occurs a partial recovery, lasting for but a short period and follow ing this there is another decrease which, with minor variations, persists to the middl of November. From then on there are sharp increases and decreases in the conten of nitrogen, in part synchronous with variations in phosphorus (November–February and in part not related with them (July–October, March and May). The highes peaks are those of January 1957 (1.06 mg/l) and February (0.740mg/l). The lacl of correspondence in the changes of nitrogen and phosphorus content is most eviden in the warm months. Another interesting fact concerns the changes in the compositio of the inorganic nitrogen compounds in the water. Between July and December mos of the inorganic nitrogen occurs as ammonia (61–84 % of the total inorganic nitrogen).I January there is a pronounced change, reflected in the increase of nitrate (Figure 6) whicl until July accounts for most of the inorganic nitrogen. These differences in the relatio between the different components of the soluble nitrogen fraction during the yea and the lack of synchronisation in the variations of nitrogen and phosphorus conten

TABLE III

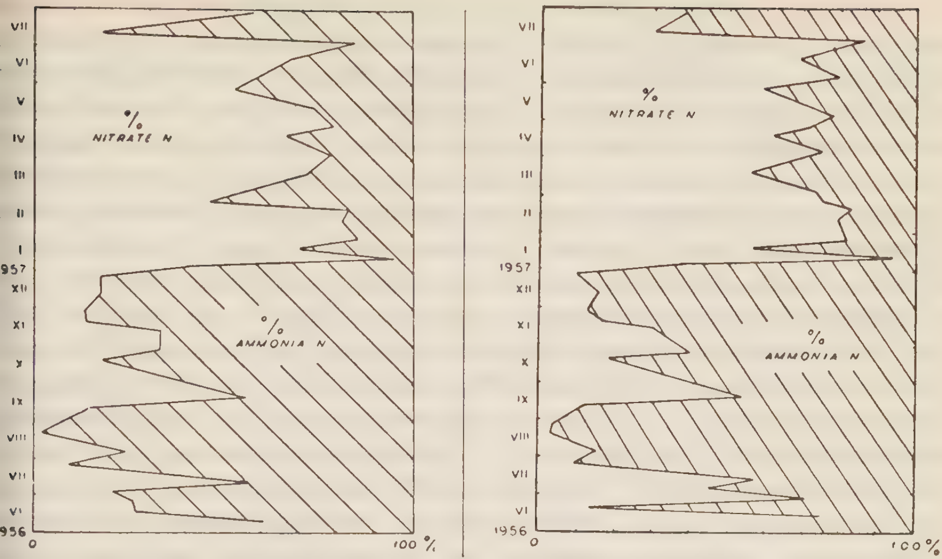
Occurrence of Plankton organisms in Lake Tiberias in weekly samples through the year 1956–1957 present + absent —

PHYTOPLANKTON		VI.56	VII	VIII	IX	X	XI	XII	I.57	II	III	IV	V	VI	VII
		1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
	CYANOPHYTA														
Chroococcales	*Aphanocapsa pulchra*	— — —	+ + +	+ + + +	+ + +	+ + + +	+ + +	+ +	+ + + +	+ — +	— —	+ + —	+ +	+ +	+ + +
	Chroococcus turgidus	— — —	— — —	— — — —	— — —	— — — —	— — —	— —	— — — —	— — —	— —	— — —	+ —	+ —	— — —
	Chroococcus minutus	— — —	— + —	— — — —	— — —	+ — — —	— — —	— —	— — — —	— — —	— —	— — —	+ —	+ —	— — —
	Chroococcus sp.	— — —	— — —	— — — —	— — —	— — — —	— — —	— —	— — — —	— — —	— —	— — —	— +	— —	+ — —
	Coelospherium dubium	— — —	— — —	+ — — —	— — —	— + — —	— — —	— —	— — — —	— — —	— —	— — —	— —	— +	— — —
	Merismopedia glauca	— — —	— — —	— — — —	— — —	— — — —	— — —	— —	— — — —	— — —	— —	— — —	— —	+ —	— — —
	Microcystis flos aquae	— · ·	+ · ·	+ + + +	+ + +	+ + + +	+ + +	+ +	+ + + +	+ — —	+ +	— + +	— +	+ +	+ + +
	Microcystis aeruginosa	— · ·	— · +	+ + + +	+ +	+ + +	+ + +	+ +	+ + —	— — —	— +	— — —	+ —	— —	— — +
Hormoganales	*Anabaena spiroides*	— + +	— — —	— — — —	— — —	— — —	+ — —	— —	— — — —	— — —	— —	— + +	+ —	+ —	— — +
	Anabaena sp.	— — —	— — —	— — — —	— + —	— — —	— — —	— —	— — — —	+ — +	— —	— — +	— +	+ —	— — —
	Aphanizomenon sp.	— — —	— — —	— — — —	— — —	+ — —	— — —	— —	— — — —	— — —	— —	+ — —	— —	— —	— — —
	Oscillatoria sp.	· — ·	— —	— + + —	+ + +	+ — + +	+ — —	+ —	— — —	— — +	— +	— — —	— —	+ +	— — +
	Spirulina platensis	— —	+ — —	— — — —	— — —	— — — —	— — —	— —	— — — —	— — —	— —	— — +	— —	— —	— — —
	Spirulina sp.	— — —	— — —	— — — —	— — —	— — + —	— — —	— —	— — — —	— — —	— —	— — —	— —	— —	— — —
	Euglenophyta														
	Phacus sp.	— — —	— — —	— — — —	— — —	— — — —	— — — —	— +	— — — —	— — —	— —	— — —	— —	— —	— — —
	PYRROPHYTA														
	Ceratium herundinella	+ + +	· — —	— — — —	— — —	— — — —	— — —	— —	— — — +	+ — —	+ +	+ — +	+ +	+ —	— + —
	Glenodinium sp.	— — —	— — —	— — — —	— — —	— — — —	— — —	— —	— — — —	— — —	— —	— — —	— —	— —	— — +
	Peridinium westii	+ · +	· + +	+ + + +	+ + +	+ + + +	+ + +	+ +	+ + + +	— — —	— —	— — —	— —	— —	+ + +
	DIATOMEAE														
Centricae	*Cyclotella* sp.	— — —	· — —	— — — —	— + +	+ — + +	— — —	— +	— — — —	— — —	+ —	— + +	— —	— +	— — —
	Melosira granulata	· + ·	+ + ·	+ + + +	· + +	+ + + +	+ + +	+ +	+ + + +	+ + +	+ +	+ + +	+ +	+ +	+ + +
Pennatae	*Cocconeis pediculus*	— — —	— — —	— — — —	— + —	— — — —	— — +	— —	— — — —	— — —	— +	— + —	— —	— —	— — —
	Cocconeis sp.	— — —	— —	— — — —	— — —	— — + —	+ — +	— —	— + — —	— — —	— —	— — —	+ —	— —	— — +
	Cymbella affinis	— — —	— — —	— — — —	— — —	— — — —	— — —	— —	— — — +	— — —	— —	— — —	— —	— —	— — —
	Cymbella sp.	— — —	— — —	— — + —	— — —	— — — —	— — —	— —	— — — —	— — —	— —	— — —	— —	— +	— + —
	Fragillaria crotonensis	— — —	— — —	+ — —	— — —	— — — —	— — —	— —	— — — —	— — —	— —	— — —	— —	— —	— — —
	Fragillaria sp.	— — —	— — —	— — —	— — —	— — — —	— — —	— —	— + — —	— — —	— —	+ — +	— —	— +	— — —
	Gomphonema ventricosum	— — —	— — —	— — —	+ + —	+ — + —	+ — —	— —	— — — —	— — —	— +	— — +	— —	— +	— + —
	Gomphonema sp.	— — —	— — —	— — — —	— — —	+ +	— + —	— —	— — — —	— — —	— —	— — —	— —	— —	— — —

	ZOOPLANKTON*	VI	VII	VIII	IX	X	XI	XII	I.57	II	III	IV	V	VI	VII
		1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
	ROTIFERA														
Brachionidae	*Anuraeopsis fissa*	— — —	— + —	— — — —	— — —	— — — —	— — —	— —	— — — —	— — —	— —	— — —	— —	— —	— — —
	Brachionus angularis	— — —	— — —	— — — —	— — —	— — — +	— — —	— —	— — — —	— — —	— —	— — —	— —	+ —	— — —
	Brachionus budapestinensis	— — —	— — —	— — — —	— — —	— — — —	— — —	— —	— — — —	— — —	— —	— — —	— —	— —	— — —
	Keratella cochlearis	— + +	+ + +	+ — — —	+ — —	— — — —	+ — —	— +	+ — — +	+ + +	+ +	+ + +	+ +	+ +	+ + —
	Keratella quadrata, valga	+ + +	+ + +	+ — + —	+ — —	+ + + +	+ — +	+ +	+ — — +	+ + +	+ +	+ — +	+ +	— —	+ — —
Trichocercidae	*Diurella rousseleti*	— — —	— — —	— — — —	+ — —	— + — —	— — —	— —	— — — —	— — —	— —	— — —	+ —	— —	— — —
	Trichocerca stylata	— — —	— — —	— — — —	+ — —	— — — —	— — —	— —	— — — —	— — —	— —	— — —	+ —	— —	— — —
Gastropidae	*Ascomorpha saltans*	— — —	— — —	— — — —	+ — —	— — — —	— — —	— —	+ + + +	+ + +	— +	— — —	— —	— —	— — —
Asplanchnidae	*Asplanchna brightwelli*	— — +	— + —	+ — — —	— — —	— — — —	— — —	— —	— — — —	+ + —	— —	— — —	— —	— —	— — —
	Asplanchna priodonta	— — —	— — —	+ — + —	— — —	— — — —	— — —	— —	— — — —	— — —	— —	— — —	— —	— —	— — —
	Asplanchna sieboldi	— — —	— — —	+ — — —	— — —	— — — —	— — —	— +	— — — —	+ + —	— +	— — —	+ —	+ —	+ — —
	Asplanchna sp.	+ — —	— — —	— — — +	— + —	— — — —	— — —	+ —	— + — —	— — +	+ —	+ + —	— +	— —	— — —
Synchaetidae	*Synchaeta pectinata*	— — —	— — —	— — — —	— — —	— — — —	— — —	+ +	— — — +	— — —	— —	— — —	— —	— —	— — —
	Polyarthra trigla	— — —	— — —	— — — —	— — —	— — — —	— — —	— —	— — — —	— — —	+ +	— + —	— —	— —	— — —
	Polyarthra vulgaris	— — —	— + —	— — — —	— — —	— — — —	— — —	— —	— — — —	— — —	— —	— — —	— —	— —	— — —
	Polyarthra sp.	+ — —	— — —	— — — —	— — —	— — — +	— — —	+ —	— — — —	— — —	— —	+ — +	— —	+ —	— — —
Testudinellidae	*Filinia longiseta*	— — —	— — —	— — — —	— — —	— — — —	— — —	— —	— — — —	— — —	— —	— — —	+ —	— —	— — —
Hexarthridae	*Hexarthra* (Pedalion) *oxyure*	— — —	+ — —	+ — — +	— — —	+ + — —	— + +	— —	— — — —	— — —	— —	— — —	— —	— —	— — —
	CLADOCERA														
Sididae	*Diaphanosoma brachyurum*	+ + +	+ + +	+ + + +	+ + +	+ + + +	+ + +	+ +	+ — + —	+ + +	+ +	— + +	+ +	+ +	+ + +
	Latonopsis sp.	— — —	— — —	— — — +	— — —	— — — —	— — +	+ —	+ — — —	— — —	+ —	— + —	— —	— —	— + +
	Pseudosida (?) sp.	— — +	— — —	— + — —	— — —	— — — —	— — —	— —	— — — —	— — —	— —	— — —	— —	— —	— — —
Bosminidae	*Bosmina longirostris*	+ — —	— — +	+ — — —	— — —	+ — + —	+ + +	+ +	+ + + +	— — —	— —	+ — —	— +	— —	— — —
	B. longirostris v. cornuta	+ + +	+ + +	+ + + +	+ — —	— — — —	— + —	+ +	— + — +	+ + +	+ +	— — —	+ +	+ —	— + —
Daphnidae	*Ceriodaphnia rigaudi*	+ + —	— — —	+ — — —	— — —	— — — —	— — —	— +	— — + —	+ + +	+ +	+ + —	+ —	+ —	— + —
	Ceriodaphnia reticulata	— — —	— — —	— — — —	— — —	— — — —	— — —	— —	— — — —	— — —	— +	— — —	+ —	— —	— — —
	Ceriodaphnia sp.	— — —	— — —	+ — — —	— — —	— — — —	— — —	— —	— — — —	— — —	— —	— — —	— —	— —	— — —
	Moina micrura	— — —	— — +	— — — —	— — —	— — — —	— — —	— —	— — — —	— — —	— —	— — —	— —	— —	— — —
	Moina rectirostris	— — —	— — —	— — — —	— — —	— — — —	— — —	+ +	— — — —	— — —	— —	— — —	— —	— —	— — —
	Moina sp.	+ — —	— — —	— — — —	— — —	— — — —	— — —	— —	— + — —	— — —	— —	— — —	— —	— —	— — —
	COPEPODA														
Cyclopidae	*Acanthocyclops c/o languidoides*	+ — —	— — —	+ — — —	— — —	— — — —	+ + —	— —	— — — +	+ — +	+ —	+ +	— —	— —	— — —
	Microcyclops minutus	— — +	— — —	— — — —	— — —	— — — —	— — —	— —	— — — —	+ + —	— —	— — +	— —	+ —	— — —
	Mesocyclops leuckarti	+ + +	+ + +	+ + + +	— — —	— + + +	+ + +	+ +	+ + + +	+ — —	— —	+ — +	— —	— +	+ + —
	Thermocyclops dybowskii	— — —	— — +	— — + —	— — —	— — — —	— — —	+ —	— — — +	— — —	— —	— — —	— —	— —	— — —
	Nauplii et Copepodidae	+ + +	+ + +	+ + + +	+ + +	+ + + +	+ + +	+ +	+ + + +	+ + +	+ +	+ + +	+ +	+ +	+ + +
	Ostracoda														
Cytheridae		— — —	— — —	+ — — —	— — —	— — — —	— — +	+ +	+ — — —	— + —	— —	— — +	+ —	+ —	— — —

* Protozoa ciliata of the genera *Epistylis* and *Vorticella* occurred several times in the samples.

	PHYTOPLANKTON	VI	VII	VIII	IX	X	XI	XII	I	II	III	IV	V	VI	VII
		1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
Pennate	*Gyrosigma* sp.	— — —	— — —	— — — —	— — —	+ + + —	+ + +	+ +	— — — —	+ — —	— —	— — —	— —	— —	— — —
	Navicula sp.	— — +	+ + —	— + — —	— — —	+ + — —	+ — +	— +	+ + — —	— — —	+ +	+ — +	— —	— +	+ — +
	Nitzchia sp.	— — —	+ — —	— — — —	— — —	— — +	+ — +	+ +	— — + —	+ — —	+ —	+ — —	— —	— +	— + —
	Synedra sp.	— — +	— — —	— — — —	— — —	— — —	— — —	— —	— — — —	— — +	— —	— — —	— —	— —	— — —
	Surirella ovalis	— + +	— —	— — — —	— — —	— — —	+ — +	— —	— — — +	+ — —	— —	— — —	— —	— —	— — —
	Surirella splendida (?)	— — —	— — —	— — — —	— + —	— — — —	— — —	— —	— — — —	— — —	— —	— + —	— —	— —	— — —
	Surirella sp.	+ — —	+ + +	— — — —	+ — —	+ + + +	+ + +	— —	— — — —	— — +	— +	+ — +	+ —	— —	+ + +
	CHLOROPHYTA														
Volvocales	*Eudorina elegans*	— — —	— — —	— — — —	— — —	— — — —	+ — —	— —	— — — —	— — —	— —	— — —	— —	— —	— — —
	Pandorina sp.	— — —	— — —	— — — —	— — —	— — — —	— — —	+ —	— — — —	— — —	— —	— — —	— —	— —	— — —
Protococeales	*Aktinastrum hantzschii*	— — —	— — —	— — — —	— — —	— — + —	— — —	— —	— — — —	— — —	— —	— — —	— —	— —	— — —
	Aktinastrum sp.	+ — —	— — —	— — — —	— — —	— — — —	— — —	— —	— — — —	— — —	— —	— — —	— —	— —	— — +
	Ankistrod esmus falcatus	— — —	— — —	— — — —	— — —	— — — —	— — +	— —	— — — —	— — —	+ —	— — —	— —	— —	— — —
	Ankistro desmus longissimus	— — —	— — —	— — — —	— — —	— — — —	— — +	— +	+ — + +	— + +	+ +	+ + +	+ +	+ +	+ + +
	Coelastrum microporum	— — +	+ — —	— — + —	— — —	— — — —	— — +	+ +	— — — —	— — —	— +	— + —	— —	+ —	— — +
	Dictiosphaerium sp.	— — —	— — —	— — — —	— — —	— — — —	— — —	— —	— — — —	— — —	— —	— — —	+ —	— —	— — —
	Lagerheimia longiseta	+ — —	— + —	— — — —	— — —	— — — —	— — —	— —	— — — —	— — —	— —	— — —	— —	— —	— — —
	Oocystis sp.	— — —	— — —	— — — —	— — —	— — — —	— — —	+ —	— — — —	+ — —	— —	— — —	— —	— +	— — —
	Closteriopsis sp.	— — —	— — —	— — — —	— — —	— — — —	— — —	— —	— — — —	— — —	+ —	+ — —	— —	— —	— — —
	Pediastrum boryanum	— — —	+ + —	— — — —	— — —	— — — —	+ — —	+ —	— + — +	+ + +	— —	+ + —	— —	— +	+ + —
	Pediastrum clathratum	— — —	— — —	— — — —	+ — —	— + + +	+ — —	+ +	+ + + +	+ + +	— —	— + —	— —	— —	— — —
	P. clathratum v. microporum	— — —	— — —	— — — —	— — —	— — + —	— — —	— —	— — — —	— — —	— —	— — —	— —	— —	— — —
	P. clathratum v. duodenarium	— — —	— — —	— — — —	— — —	— + — —	+ — +	— +	— + — —	— — —	— —	— — —	— —	— —	— — —
	P. duplex v. clathratum	— + +	+ — —	— + — +	— — —	+ + — +	+ — +	— +	+ — + +	— + +	+ —	+ — +	— —	— —	+ + —
	P. duplex v. reticulatum	+ — —	— — —	— — — —	— — —	— — — —	— — —	— —	— — — —	— — —	— —	— — —	— —	— —	— — —
	P. ovatum	— — —	— — —	— — — —	— — —	— — — —	— — —	— —	— — — —	+ +	— —	— — —	— —	— —	— — —
	P. simplex v. typica	— — —	— — —	— — — —	— — —	— — — —	— — +	— —	— + — +	+ —	+ —	+ + —	+ —	— +	— — —
	P. simplex v. radians	— — —	— — —	— — — —	— — —	— — — —	— — —	— —	— — — —	— +	— —	— — —	— —	— —	— — —
	Scenedesmus acutiformis	— — —	— — —	— — — —	— — —	— — — —	+ — —	— —	— — — +	— + +		— — —	— —	— —	— + —
	Scenedesmus bijugatus	— — —	— — —	— — — —	— — —	— — — —	— — —	— —	— — — —	— — —	+ —	— — —	— —	— —	— — —
	Scenedesmus obliquus	— — —	— — —	— — — —	— — —	— — — —	— — —	— —	— + — —	— — —	— —	— — +	— —	— —	— — —
	Scenedesmus obtusus	— — —	— — —	— — — —	— — —	— — — —	— — —	— —	— — — —	— — —	+ —	— — —	— —	— —	— — —
	Scenedesmus quadricauda	— — —	— + —	— — — —	— — —	— — — —	— — —	+ +	— + — +	— + +	— —	+ — +	+ +	+ +	— — —
	Selenastrum gracile	— — —	— — —	— — — —	— — —	— — + +	— — —	— +	— — — —	— — —	— —	— — —	— —	— —	— — —
	Tetraëdron sp.	— — —	+ — —	— — — —	— — —	— — — —	— — —	— —	— — — —	— — —	+ —	— — —	— —	— —	— — —
	Gloeocystis sp.	— — —	— — —	— — — —	— — —	— — — —	— — —	— —	— — — —	— — —	— —	— — —	— —	— —	+ — —
	Sphaerocystis sp.	— — —	— — —	— — — —	— — —	— — — +	— — —	— —	— — — —	— — —	— —	— — —	— —	— —	— — —
Ulotrichales	*Microspora stagnorum*														
Heterocontae	*Botryococcus braunii*	— — —	— — —	— — + —	— — —	— — — +	— + +	— +	— — — —	— — —	— —	— — —	+ —	+ —	— — —
	Chlamydobotris sp.	— — —	+ — —	— — — —	— — —	— — — —	— — —	— —	— + + —	— — —	— —	— — —	— —	— —	— — —
Conjugatophyta	*Closterium* sp.	— — —	— + —	— — — —	— — —	— — — —	— — —	+ +	— + + —	— — —	— —	— — —	— —	— +	— — —
	Cosmarium sp.	— — —	— + +	— — — —	— — —	— — — —	— — —	+ —	— — — —	+ — —	— —	— — —	— —	— +	— — —
	Staurastrum gracile	— — —	— + —	— — + —	— — +	— — — —	— — —	— —	— + — +	+ + +	— +	+ — —	— +	— —	— — —
	Staurastrum muticum	+ — —	— — —	— — — —	+ — —	— — — —	— — —	— —	— — — +	— — —	— —	— — —	— —	— —	— — —
	Staurastrum sp.	— — —	+ — —	— — — —	— — —	— — — —	— — —	+ +	— — + —	+ + +	— +	+ + —	— —	— —	— — —



(a) (b)

Figure 6
Seasonal variations in the relation of Nitrate Nitrogen and Ammonia Nitrogen in %.
a — Surface; b — 5m depth

rom July to December are presumably at least in part due to the biological activity of lue-green algae (Cyanophyceae) which multiply in the lake during this period.

Other elements

In our series of chemical analysis no marked variations were observed in the oncentration of the elements listed in Table I, which shows the concentrations of Na^+, K^+, Ca^{++}, Cl^-, So_4^{--}, in the water of Beit Yerah.

TABLE I

Conc.	Na	K	Ca	SO_4	Cl
Aver.	120.0	7.9	40.9	51.7	306
Min.	85.0	7.25	31.0	48.5	295
Max.	157.0	8.64	47.5	55.5	320

THE BIOTIC ACTIVITY

n attempt has been made to evaluate the biotic activity in Lake Tiberias from several spects: Variations in the net plankton biomass in the course of the year; 2) Meaurements of the plankton community respiration–oxygen consumption in the lake;) Primary production; 4) Changes in plankton components.

Respiration and primary production were estimated by determining the oxygen ontent, in dark and clear bottles. For this purpose samples were obtained from the

surface and from 5m depth. Bottles with water from both depths were kept for 4 hours 40cm below the surface of the lake. At the time samples were taken, oxygen content of the lake water at both depths was measured. The difference between oxygen content of the lake water at the beginning of the experiments and that of the dark bottle provides a measure of the respiration of the plankton organisms, including bacteria.

In this connection it must be mentioned that in 11 cases, out of a total of 84 experiments, no difference whatever was found between the oxygen content in the lake in the dark bottle, after its exposure for 4 hours, and in 9 cases the oxygen content in the dark bottle even slightly exceeded the oxygen content in the lake at the time of sampling. A similar phenomenon is discussed by Wallace and Dugdale (1960) who, in their studies of photosynthesis in Alaska found oxygen values of the dark bottles to exceed those of the clear bottles. They state that this occurred in many cases and is therefore not likely to be due to an experimental error. The same phenomenon is again discussed by Gessner and Pannier (1958) who point out that the rate of respiration in opaque bottles will be unduly low with low oxygen pressure. However, in our own experiments the lack of a difference between the oxygen content of the opaque bottles and the initial oxygen content of the lake was observed even when oxygen was present at a concentration exceeding saturation as well as at saturation values of 85%. In some instances respiration in the lake was too weak to be determined by Winkler's method using thiosulphate 0.01 N. After repeatedly coming up against this, titration with thiosulphate 0.005 N was introduced.

Some of the cases maybe due to microstratification of oxygen content above the bottom layer of the lake. It is possible that while sampling the water, the oxygen content in the control bottle was by some hundredths of milligrams smaller than in the opaque bottle. However, the recurrence of this in many cases proves that no experimental error is involved. It is suggested that in planning experiments, the possibility should be taken into account that a second Control will be necessary and, therefore, three bottles, instead of two, should be used in every instance. At the same time, it is advisable to titrate only part of the water in each bottle in order to retain some water for a repeat measurement whenever necessary. This advocated with reason by Steeman Nielsen (1958).

An error of the kind discussed will yield respiration values much smaller than the true values. It was the purpose of our analysis to obtain comparative data on the variations in the intensity of biological processes throughout the year. The possibility that in some instances unduly small values were obtained does not deter from the significance of the general picture obtained.

A. The biomass of the net plankton

Plankton was collected in two ways: 1. By filtration of 50 litres of water obtained with a container of 1 litre capacity, close to the surface, through a plankton net no. 20 2. By vertically hauling a plankton net of 500cm^2 area from a depth of 5m. Some idea on the plankton biomass in a 5m water column extending over 1m^2 is provided by the figures in Table II. These indicate some interesting features of the dynamics

TABLE II

Occurrence of net plankton biomass in water column below 1m^2 *surface (plankton biomass in* cm^3)

Size class.	2.1-4.0	4.1-6.0	6.1-8.0	8.1-10.0	10.1-12.0	12.1-14.0	14.1-16.0	16.1-18.0	18.1-20	X
June 56	—	—	1	1	—	1	—	—	—	10.34
July	—	—	1	1	—	—	—	—	1	12.0
Aug.	—	—	2	—	1	—	1	—	—	10.2
Sept.	1	1	—	—	1	—	—	—	—	7.2
Oct.	1	1	1	1	—	—	—	—	—	6.1
Nov.	—	—	1	2	—	—	—	—	—	8.86
Dec.	—	—	1	—	—	—	—	—	1	13.20
Jan. 57	—	—	—	1	—	—	2	—	1	15.0
Feb.	—	1	—	—	1	—	1	—	—	9.46
March	—	1	—	—	1	—	—	—	—	9.50
Apr.	1	1	1	—	—	—	—	—	—	5.40
May	1	—	1	—	—	—	—	—	—	5.50
June	—	—	—	1	1	—	—	—	—	5.90
July	2	1	—	—	—	—	—	—	—	4.14

of plankton in the lake. The most salient point concerns the frequent and rapi change in plankton biomass. The decrease from a high peak to a low point, an conversely the increase to a peak were noticed week after week. (Figures 7a, b

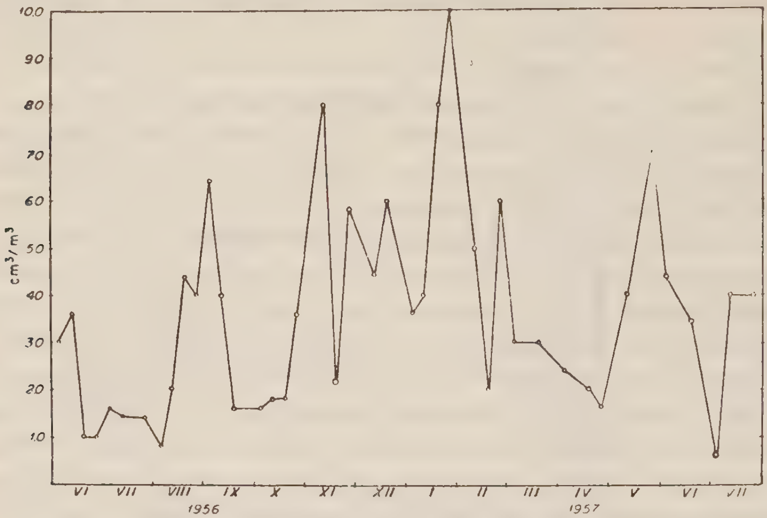


Figure 7 (a)
Seasonal changes in plankton biomass — Surface in cm³/m³

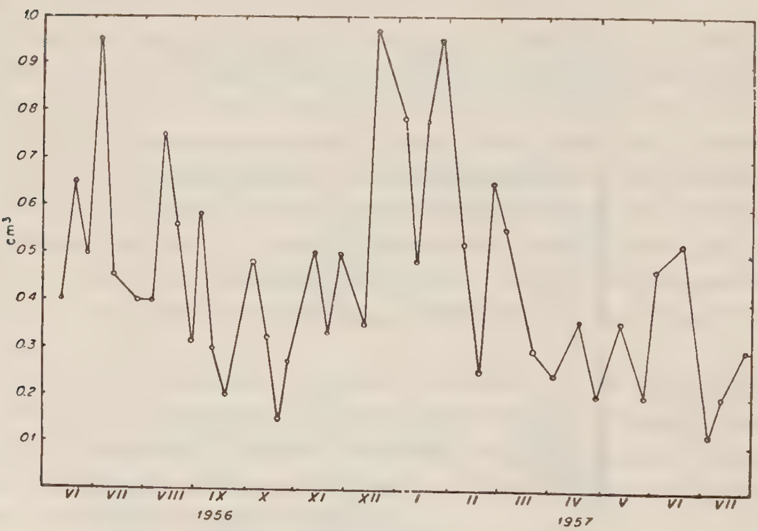


Figure 7(b)
Seasonal changes in plankton biomass in water column below 1m² surface — Vertical haul from 5m depth to surface

These abrupt variations make it difficult to determine periods of peaks and lows. I several cases, both the highest biomass and the lowest biomass were recorded in single month. High values occurred in July, August and December, 1956, and agai in January and February, 1957. The lowest values occurred in September and October

956, April, May and July, 1957. A second point of interest is the lack of agreement the variations of the plankton biomass in the surface water and in the whole 5m olumn. Thus in July, 1956, the biomass for the whole column in creased abruptly and onsiderably — following the low values of June — and again in August, following e low values of July. At the same time, the plankton biomass determined for the urface water showed a continuously low level, beginning at the end of June and sting to the middle of August, and a similar situation holds in September, October, Iarch and April. Surface plankton shows very pronounced peaks in November, 956 and again in May, 1957, neither of which are shown by the curve for plankton omass of the whole column. On the other hand, there are very pronounced peaks the biomass of the 5m column in July, October and December, 1956 and June, 957. The reason for this lack of agreement may have to be looked for in the different tios between the phytoplankton and the zooplankton in the course of the year. igure 8 shows the ratio, in percent, between the number of organisms in the zoo-

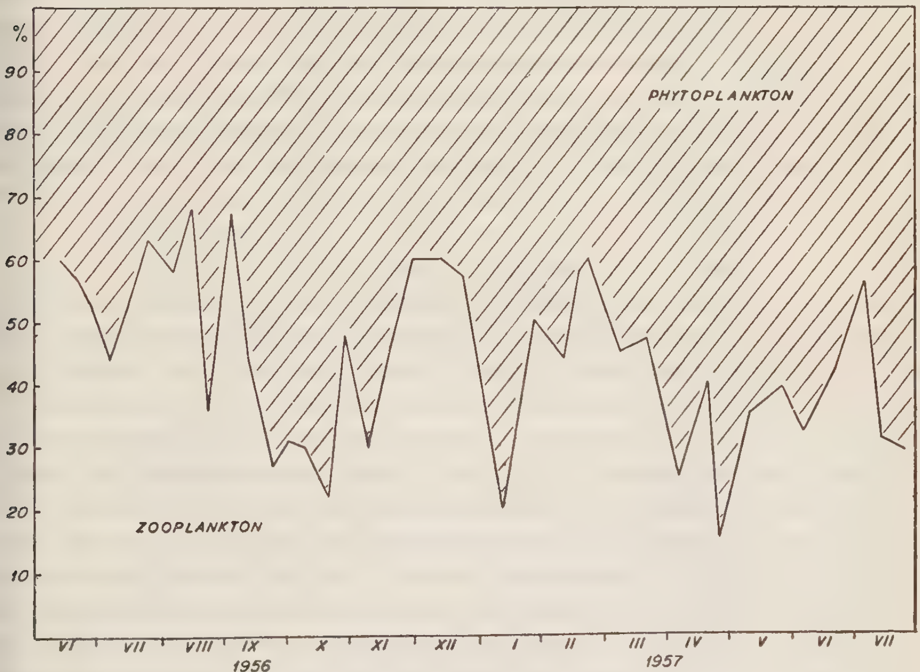


Figure 8
Seasonal changes in the relation between zooplankton and phytoplankton in %.

lankton and the phytoplankton. Considering the tendency of the zooplankton o move away from the surface of the lake towards the bottom, during the hours of trong sunshine, it is possible that the difference in biomass between the surface

water and the whole 5m column is due to the diurnal movements of some of the orga isms comprising it. When zooplankton organisms are more numerous than those the phytoplankton, the plankton biomass for the whole column will increase mo rapidly than that of the surface water. Comparing the variations in the plankto biomass with the relative composition of the plankton, as reflected in the rat between its two components, it is apparent that the increase in the quantity of zoop ankton is directly responsible for the strong peaks recorded in the plankton bioma for the whole column in July, December, February and March which do not sho in the data for surface plankton.

B. *Consumption of oxygen* (*respiration*)

The best parameter for estimating the intensity of biological processes is provide by measurements of oxygen consumption during the day. The data presented Figure 9 provide an altogether different picture from that obtained with data on t plankton biomass. In oxygen consumption, as in other factors measured, there a variations from week to week which, however, are not in agreement with variatio

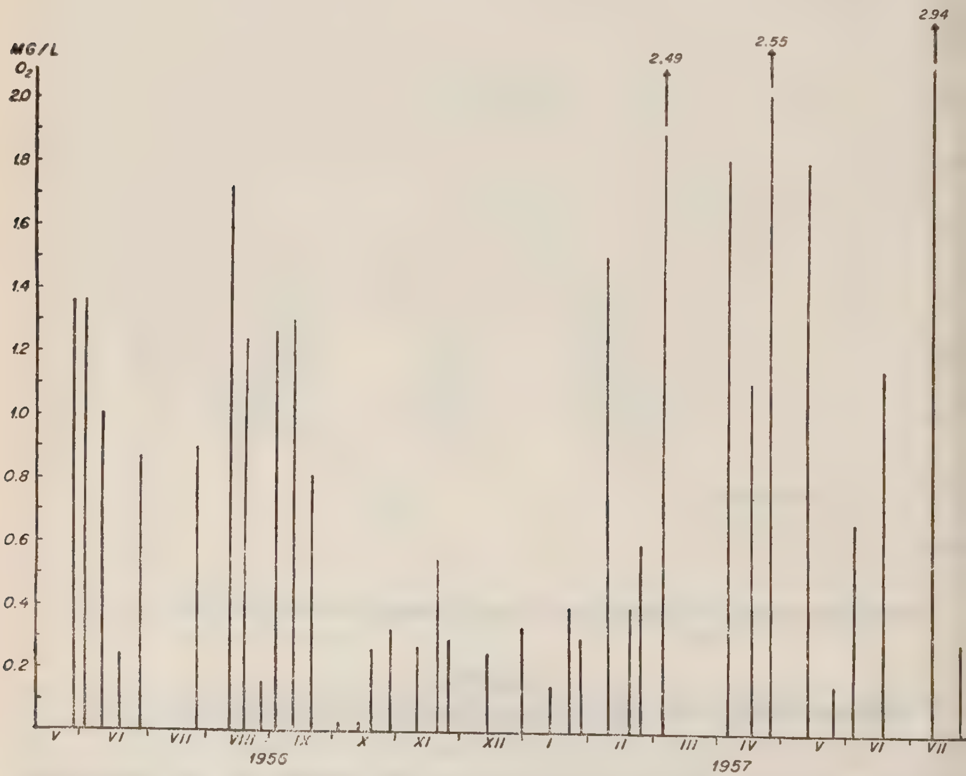


Figure 9

Oxygen consumption; each vertical represents 24 hours consumption, computed from week observations.

ı the net plankton biomass. On the basis of oxygen consumption, the year may be onveniently divided into several periods:

) A period of intensive summer activity from June to September;

) A period of low oxygen consumption, from the middle of September to the ıd of January;

) High consumption from February to May;

) From May to the middle of June there is at first a decrease and again an increase ı oxygen consumption.

This division of the year into two periods of high consumption and two periods of ›w consumption is characteristic of the biological activity in Lake Tiberias. The ength of these periods and the variations in oxygen consumption in each vary from ear to year.

The lack of agreement between variations in the net plankton biomass and oxygen onsumption has already been mentioned. This is most pronounced in December nd January, when oxygen consumption is low, at a time when the plankton biomass ıcreases rapidly. In this case, the lack of agreement observed may be due to the low xygen consumption by the plankton organisms, resulting from the low water- temperaıres prevailing at the time. However, the inverse phenomenon, i.e. a strong increase in xygen consumption in March and, more particularly ,in April — at a time when the lankton biomass decreases and temperatures are still increasing very slowly — ıdicates that the main consumers of oxygen are not the organisms composing the et plankton but the nanoplankton, including bacteria (Rodhe 1956).

C. *Primary production*

Another measure of biological activity is provided by the intensity of photosynıesis. Our data on assimilation are limited to observations lasting only four hours, t an illumination approaching optimal intensity. These data provide only partial ıformation on primary production in Lake Tiberias near Beit Yerah. To complete ur information it would have been necessary to determine the effect of variations of ght intensity during the day, of length of day and of cloudiness on the rate of assimilaon. Without these figures it is difficult to calculate the balance of pr˙mary producon. However, the measurements provided in this study may serve as a good basis ›r comparing the biological activity of the phytoplankton in different seasons.

Intensity of assimilation again shows considerable changes from week to week. he extent of these variations differs from season to season, as shown in Figure 10. ssimilation is highest in February and March, but even then it is far from steady. is lowest from the end of September to January, when the weekly variations also ach lowest values. Between these stages, the minimum of October–December and e maximum of February–March, an intermediate rate of assimilation as well as termediate variability of this rate prevail. There is agreement between the variations ı respiration and rate of assimilation, but agreement between rate of assimilation nd plankton biomass is only partial. In summer, June to September 1956, variations

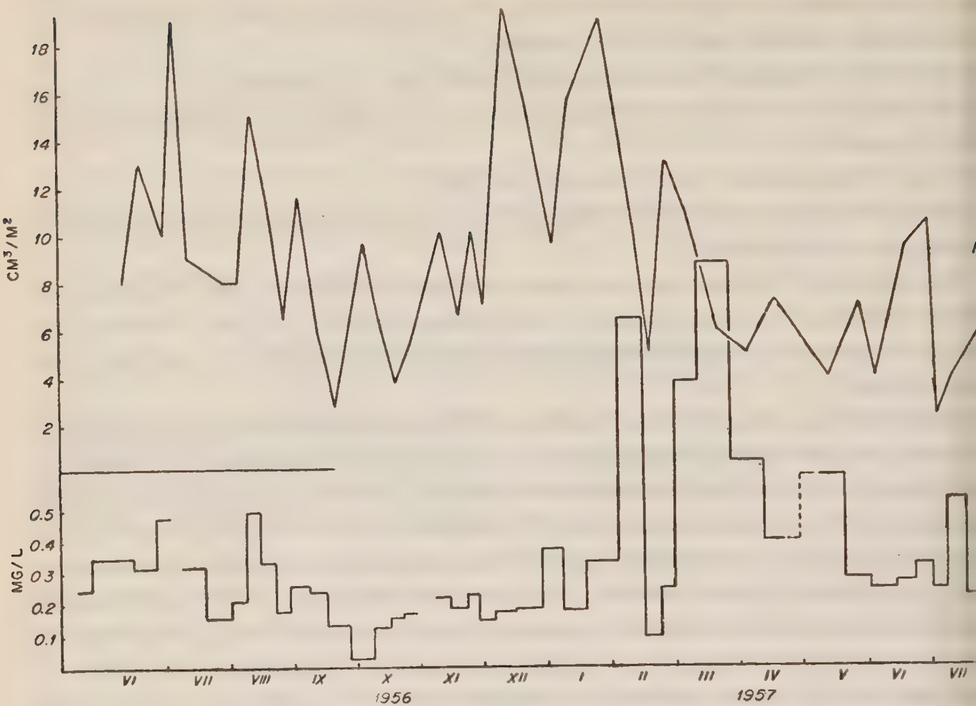


Figure 10
Assimilation activity of phytoplankton (mgO_2/l) during a four hour period exposure and
plankton biomass (cm^3 below 1 m^2 surface), throughout the period of observations.

in rate of assimilation occurred parallel with variations in plankton biomass. Ev the decrease in rate of assimilation to its lowest value in October is in agreement wi the decrease in the plankton biomass. However, whereas there occurs a sharp i crease in plankton biomass already in December, assimilation (first) increases or in February. At this time, there is no correlation between plankton biomass and ra of assimilation. The increase in plankton biomass depends on the development the zooplankton, which precedes that of the phytoplankton.

This lack of agreement between assimilation and plankton biomass on the o hand and the parallelism shown by the variations in the intensity of respiration a photosynthesis on the other, enable us to obtain indirectly an idea of the activity nanoplankton, and its place in the dynamics of the biological processes in the lal In collecting data on assimilation we were mainly interested in obtaining a comparis of the biological activity of the phytoplankton in the course of the year. Yet, recognised that they also provided some estimate of the intensity of primary produ tion in Lake Tiberias in different months. In order to obtain the daily rate, the as milation per hour — obtained from our four-hourly exposures — was multipli by the number of hours from sunrise till sunset. This estimate of the production of

ic matter will be somewhat in excess of the true value of assimilation, as the values
ained during our four-hourly exposures refer to optimal conditions of illumi-
ion. To correct this error, at least in part, data on direct solar radiation obtained
h a heliograph were consulted (these data were kindly put at our disposal by
eit Gordon", Degania). The product of photosynthesis per hour and the number
iours of direct sun radiation provides a second estimate of assimilation in the lake.
s assumed that the true production of organic material in the lake is somewhere
ween these two estimates.

The variations in the rate of photosynthesis as a result of changes in radiation are
te small during most hours of the day. According to Steeman Nielsen, a reduction
50% in the intensity of light reduces photosynthesis by only 10%; whereas the
uction of light intensity to 10% from optimal values, reduces photosynthesis
50% (Nygaard 1953). Similarly, Hepher, working on primary productivity in
ponds in Israel states that photosynthesis, measured per unit of volume, rises
uptly soon after sunrise and reaches maximum values after only three hours. These
sist throughout the day until shortly before sunset, when an abrupt decrease in
otosynthesis is evident (Hepher, personal communication). This course of photo-
thesis in water basins shows that our method of computing the daily rate of
imilation at Beit Yerah provides reasonable estimates.

The estimates of photosynthesis in the Bay of Beit Yerah are intended to provide
ne idea of the development of biological activity in the Lake and are not meant to
ve as detailed comparative figures to be used in estimating the rate of production
organic matter in the Lake, as compared with other water basins. It should not be
gotten that our experiments were all conducted at 40cm below the surface of the
er. Also, as stated above, this little bay is open towards the Lake and its water
asily mixed. Therefore, our figures provide but a rough estimate of the character
he processes occurring in the Lake. Figure 11 gives the values for photosynthesis,
y respiration and oxygen saturation. These indicate that February, March and
ril are the months during which most of the surplus primary organic material is
duced, in spite of the rather short days in this part of the year. However, it should
pointed out that our evaluation of the production of organic material during these
nths is only preliminary, based as it is on the assumption that the rate of assimi-
on, as measured in our samples, applies to the whole Lake and to all depths. It is
highly probable that a study of the primary production throughout Lake Tiberias
ll depths will provide a different picture from that obtained in our preliminary
earch. In summer, from May to September, primary production is comparatively
, yet oxygen consumption — which may in fact be more correctly described as
rocess of destruction — is in excess of production during this time. October–
ember are the months of least production, yet, in spite of this, production is in
ess of consumption. There is an interesting parallelism between production,
sumption and oxygens aturation of the water. From February onwards oxygen
ration increases steadily to a value of 150%. This high value is a result of biologi-

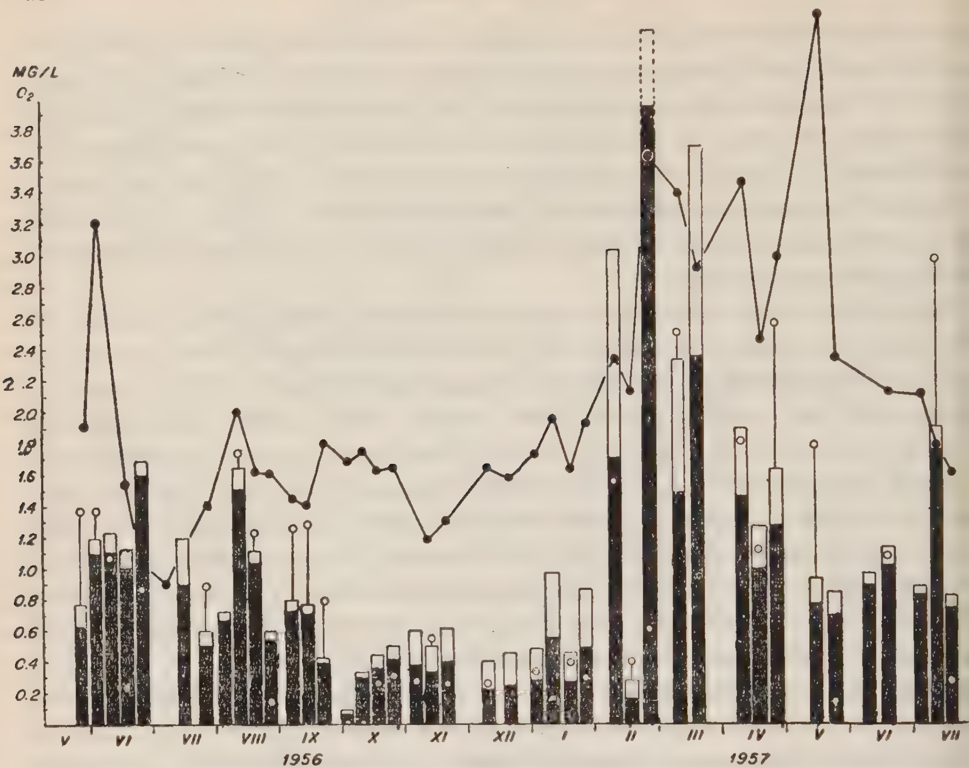


Figure 11

Primary production gross values (mgO_2/l); vertical columns — values obtained consider time from sunrise till sunset; in black values obtained considering time of direct sun radiati only (as explained in text); white circles — oxygen consumption; solid line — oxygen saturati

cal activity of the phytoplankton which leads to a positive difference betwe photosynthesis and oxygen consumption in the Lake. During the summer mont oxygen saturation decreases steadily and comsunption is in excess of photosynthes There is a lack of agreement between oxygen concentration in the water and t balance of photosynthesis and consumption which lasts from October to Novemb when saturation continues to decrease, reaching a minimum at a time when a posit difference of photosynthesis occurs.

This situation may be surprising when it is remembered that data for oxyg concentration refer to the upper 5m, which are naturally in rather close cont with the air and subject to constant turbulence. The explanation of the inverse ra between perce nt of oxygen saturation and photosynthesis must be sought in t exchange of water taking place between the Bay of Bet Yerah and the deeper lay in the Lake. From May onwards, when the thermocline becomes stabilised, the conc tration of oxygen below the depths of 15–16m decreases to zero (Yashouv, unpublish data). Under the influence of wind-action, water masses without oxygen rise fr the depths of the Lake and lower the oxygen concentration near its surface. Dur

ɔng storms, water without any oxygen, saturated with H_2S, may rise from the ɔths at such a rate that fish mortality may result locally along various sections of the ɔre.

Γhe exchange of water with low oxygen content or without oxygen, between the ver layers of the Lake and its surface presumably occurs throughout most summer 's under the influence of the prevailing wind. This may in fact be the main reason the high consumption of oxygen noted in the Lake during this period, as well as its depletion in the upper layer, which occurs even when the process of intense neralisation gradually slows down and stops.

n view of this fact, primary production in summer may be considered as sufficiently ense to balance the high rate of consumption. The sharp decrease in oxygen saturon in November indicates the incipient disturbance of the summer stagnation, h consequent mixing of the upper layers of the water with the lower layers marked low oxygen content or altogether without oxygen.

D. *Variations in net plankton*

Γable III shows the variations in the composition of the net plankton and provides st of the plankton organisms collected and determined by the authors. Even though y material collected at one locality is included, the list contains some species not viously recorded from Lake Tiberias. Among the Copepods, *Microcyclops minutus* l *Acanthocyclops* are reported, and a number of species of *Moina* of the Cladocera previously found in the plankton of Lake Tiberias. Among the Sididae, a species *Latonopsis* was found which, according to some authors, differs from *Diaphanosoma* he presence of anal spines on the postabdomen. Among the Rotatoria, *Asplanchna ɔoldi* was recorded. Whether the finding of these species indicates changes in the na of Lake Tiberias or else is due to the specialised habitat which was the subject ɔur study and overlooked in previous studies cannot be ascertained at this stage. he present summary these questions are not considered further, as we were only inested in the analysis of the dynamics of the biological processes in Lake Tiber- A discussion of the appearance and distribution of plankton organisms in the ke will be published elsewhere on the basis of further observations.

Γhe variations in the composition of the plankton and the quantitative relations ween various groups of organisms are indicated by the percentage relation between ividuals. This method of presentation admittedly has some disadvantages as percentage relation between individuals of different species does not properly ress the true quantitative relation between groups. Thus a colony of *Microcysties* onsidered as equivalent to a filament of *Melosira* and to a single cell of *Peridinium*; otifer is considered equivalent to a Cladoceran and *Cyclops*. However, the changes he relations of various groups are very striking and do provide a clear picture of successional processes and of the variations in the floristic and faunistic aspects he Lake.

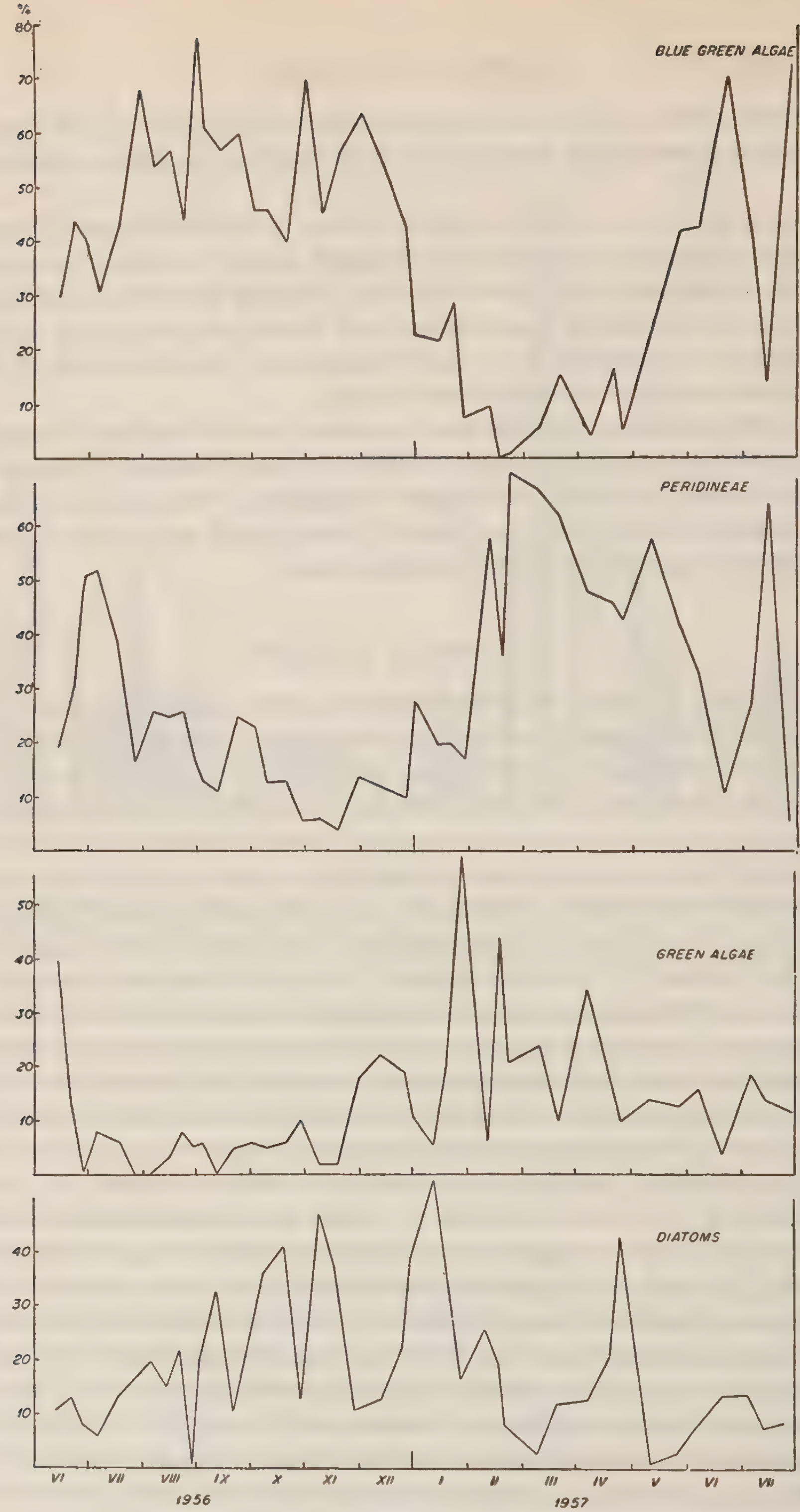


Figure 12
Changes in composition of phytoplankton, standing crop (% of individuals).

THE PHYTOPLANKTON

ıe following species predominate; among the blue-green algae, *Microcystis* and d *Aphanocapsa*; among the green algae, only a single species was on rare occasions, presented by a large number of individuals so as to dominate the algal population. one case this was a *Scenedesmus*, in another, a species of *Ankistrodesmus* and in hird case, a *Staurastrum*. The variations in the composition of the phytoplankton graphically presented in Figure 12. Beginning with the intense development of the ınkton in February, and lasting till summer, Peridineans, and in particular *Peridi-ım westii* — which gives the water a brownish tinge — predominate. With the vent of summer, from about July, blue-green algae become the dominant compon-t of the phytoplankton and the number of their representatives (colonies) exceeds %. Considering that each colony is counted as one specimen, the true importance the blue-green algae in the plankton biomass is in fact even greater. The increase the number of blue-green algae in the plankton observed during summer seems to ve some effect on the nitrogen cycle in the Lake. Beginning in the middle of De-mber, the percent of blue-green algae in the plankton decreases rapidly and remains a low level until summer. In autumn, Diatoms become predominant and in winter, pecially in January, they are the main components of the phytoplankton. During e period of our observations, another short lasting increase in the percentage of iatoms was recorded in April.

Various species of green algae occur throughout the year but, as already pointed t, only on rare occasions and for brief periods do some of these become dominant mponents of the plankton. The rise in the number of Peridineans in the plankton the end of the winter concludes the cycle of the changes in phytoplankton.

THE ZOOPLANKTON

ıe three main groups comprising the zooplankton, the Rotatoria, the Cladocera and clopidae are represented throughout the year. Together, they account for over species collected in the Bay of Beit Yerah. Some of these are found at every mpling, while others disappear periodically, to be replaced by different species. gure 13 shows the variations in the composition of the zooplankton. It indicates me interesting quantitative relations between these groups. Beginning in June and ting for almost ten months, until April, the Cyclopidae dominate the zooplankton. May–June the Cladocera become more numerous. It is of interest that this rise the number of Cladocera occurs at a time when the percent of Cyclopidae decreases. is possible that this antagonism, shown by the quantitative variations of the two oups, is due to the different ecological requirements of their representatives, and therefore, conditioned by the persistent changes in the ecological factors which courage or reduce the development of the population of different species. Else, it ıy be the result of the intense increase of the Cyclopidae which dominate the water d thereby interfere with the development of the Cladocera. This problem though licated by the data obtained in this research, cannot be settled unless more is

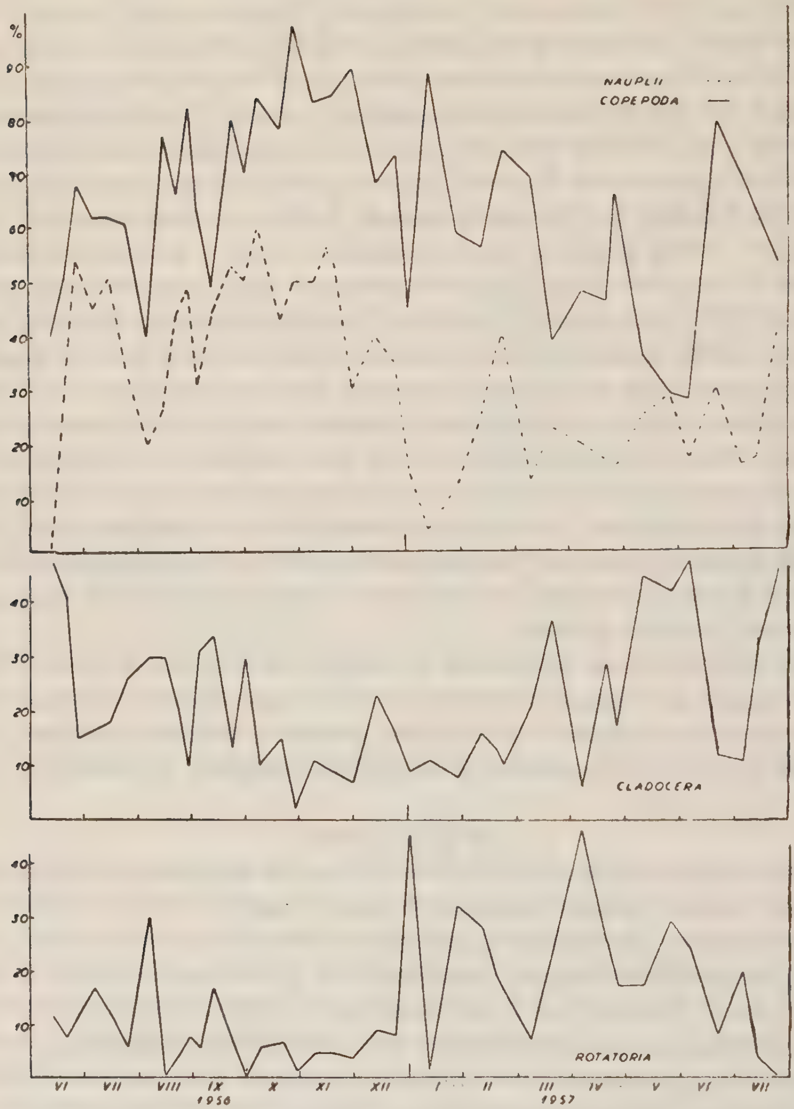


Figure 13
Changes in composition of zooplankton, standing crop (% of individuals).

known on the physiology and the ecological requirement of the relevant specie

The variations in the percent of Rotatoria in different samples do not show an relations to corresponding variations in the Copepoda and Cladocera. The marke increase in the number of Rotatoria in several cases is directly dependent on th specific dynamics of the population of each individual species.

SUMMARY AND DISCUSSION

was the purpose of our research to discover the pattern of the biological processes 1 Lake Tiberias. Attempting to sum up our observations, a complex set of relations etween different groups of organisms becomes evident.

The objective conditions, reflected by the observations conducted in this research ıake it possible for plankton communities to reach their full development, and this oes in fact appear in our data. Nutrient salts, though subject to marked variations ever become wholly depleted; temperature, oxygen content and *p*H never reach xtreme values likely to have any harmful effect on the organisms. Nevertheless, ıere are frequent variations in population.

Phytoplankton and zooplankton alike each comprise several different populations. ach of these populations reaches its peak in a short period and then declines ıaking place for another population. This rapid change in populations which nder the varying environmental conditions fully exploit the carrying capacity f the environment, raises the productivity of the Lake. In other words, these freuent variations prevent or shorten the stationary state in the development of poputions which is a harmful phase in the productivity of a lake (Margalef 1960, Ryther nd al. 1958).

In attempting to understand the nature of the biological processes observed, the eriod from end of winter to early spring must be regarded as the main period for ıe production of organic material and showing at the same time a climax in the evelopment of the populations. At this time, too, the highest biomass of the net lankton was measured.

We shall not go wrong if we regard this period as the central phase for the storage f energy in the organic material, i.e. the plankton .This energy sybsequently serves ıe various decompositors for the greater part of the year. This outburst of the net lankton occurs at the end of overturn follows the stagnation observed during ımmer. The temperature becomes uniform throughout the depth of the Lake and ll layers become saturated with oxygen. Plankton composition itself does not, as et, show any changes. The phytoplankton is dominated by blue-green algae and the ooplankton by copepods. Primary production is still low. The first increase in the mount of plankton observed in December is due to the multiplication of the zoolankton, which precedes the increase in the phytoplankton. In January, Diatoms and eridineans become more frequent in the phytoplankton and the Rotatoria increase 1 the zooplankton. The fundamental change occurs in February. It is continued in Iarch, when the Peridineans *Ceratium* and *Peridinium*, occurring either together or se replacing each other, dominate the phytoplankton.This is anologous to the succeson observed in the sea when Perideans replace Diatoms (Margalef 1960). The ladocera become more frequent in the zooplankton and primary production reaches s highest value. Quantitatively plankton populations occurring in this period and rimary production reach their upper value which prevails for only a short time to be

followed by a period of decline. The dead and decomposing organisms involve a high oxygen consumption which increases with the rise in temperature. New groups of plankton organisms, blue-green algae and Copepods, make their appearance Exploiting the favourable environment they rapidly develop and reach a peak valu and then decrease before recovering another time.

Two types of factors affect the plankton populations and biological processes in the Lake. The first of these are the density dependent factors which regulate th numerical development of the population. The second comprises climatic factor and mixing of water from various layers which involve changes in the compositio of populations. Changes in the biomass and in the rate of oxygen consumption an primary production may be identical and in agreement or else different and out o step. All of these variations indicate the complex character of the biological processe of the Lake.

We have endeavoured to describe the biological processes and their dynamic in Lake Tiberias by following events in a limited area of the Lake and collectin samples during day hours only. We could not consider in our limited study pro- cesses like movements of water masses, the accumulation of metabolites an diurnal variations in the activity of organisms which give a picture of rapid fluc tuations in populations and affect the activity of the organisms. (Nielsen 1958, Ohl 1958, Rohde et al. 1960, Berg 1958) — all of these factors are reflected in the reaction of living organisms which account for the state of equilibrium between differen populations and their environment. To quote Bodenheimer:

"The frame for all conclusions is that populations are self-governing systems whic regulate their densities in relation to their own properties and to those of the environ- ment below the threshold of favourability... These factors hold populations in balance

The very ambiguous word "balance" is defined as: "sustained and effective com- pensatory reaction which maintains populations in being in spite of eventually violen changes in the environment and which adjusts their densities in general conformit with prevailing conditions.

Far from being a stationary state, balance is commonly a state of oscillation abou the level of equilibrium-density which is forever changing with environmenta conditions. These are very unusual interpretations of the terms "balance" and equi- librium, but they are the only possible ones if we wish to continue their use in biolog (Bodenheimer 1958).

ACKNOWLEDGEMENT

The authors wish to express their thanks to Dr. B. Hepher for his critical reading o the manuscripts and valuable discussions, and to Mr. A. Hefetz for help in drawin the diagrams, both of the Fish Culture Res. Sta.

REFERENCES

BERGE, G., 1958, The primary production in the Norwegian Sea in June 1954, measured by an adapted 14C technique, *Rapp. et Proc. Verbaux*, **144**, 85 91.

BODENHEIMER, F.S., 1958, *Animal Ecology Today*, Dr. W. Junk, Hague.

DUGDALE, R. C. AND WALLACE, J. T., 1960, Light and dark bottle experiments in Alaska, *Limnol. and Oceanog.*, **5** (2), 230 231.

GESSHER, F. AND PANNIER, F., 1958, Influence of oxygen tension on respiration of phytoplankton, *Limnol. and Oceanog.*, **3** (4), 478 480.

KOMAROVSKY, B., 1959, The plankton of Lake Tiberias, *Ministry of Agriculture, Div. of Fish., Sea Fish. Res. Sta.*, *Bull.*, **25**, Israel.

MARGALEF, R., 1960, Temporal succession and spatial heterogenity in phytoplankton, *Perspectives in Marine Biology*, pp. 323-347.

NIELSEN, S.E., 1958, Experimental methods for measuring organic production in the sea, *Rapp. et Proc.-Verbaux*, **144**, 38 46.

NIELSEN, S.E., 1958, Light and the organic production in the sea, *Rapp. et Proc.-Verb. des Réunions*, **144**, 141–148.

NYGAARD, G., 1955, On the productivity of five Danish waters, *Verh. Internat. ver. Limnol.*, **12**, 123–133.

OHLE, W., 1958, Diurnal production and destruction rates of phytoplankton in lakes, *Rapp. et Proces-Verbaux*, **144**, 129-131.

RODHE, W., VOLLENWEIDER, R.A. AND NAUWERCK, A., 1960, The primary production and standing crop of phytoplankton, *Perspectives in Marine Biology*, pp. 299-322.

RODHE, W., 1958, The primary production in lakes, some results and restrictions of the 14C method, *Rapp. et Proces-Verbaux*, **144**, 122-128.

RYTHER, J.H., YENTSCH, C.S., HULBURT, E.M. AND VACCARO, R.F., 1958, The dynamics of a diatom bloom, *Biol. Bull.*, **115**, 257.

EXTRINSIC CONTROL OF ENDOCRINE FUNCTIONS IN INSECTS

J. DE WILDE

Laboratory of Entomology, Agricultural University, Wageningen, Holland

ABSTRACT

A brief review is given of the internal and external factors controlling the endocrine system of insects. Stress is laid on environmental control, exerted by photoperiod, temperature, food, host-parasite interaction and social conditions. It is argued that reproduction, diapause (also in adult insects) as well as seasonal and social polymorphism are a function of hormone levels both of the corpora allata and prothoracic glands.

The neurosecretory cells in the brain are the primary centre of endocrine activity. It appears that many ecological factors exert their influence via this centre, thus regulating the activity of the subordinated glands.

This is clearly exemplified in some cases of parasitic castration and host-parasite synchronization, but very probably it is also valid for the action of photoperiod, temperature and food on diapause and reproduction. It appears, therefore, that the neurosecretory cells play a decisive part in integrating the insect into its environment.

In recent years, insect endocrinology has advanced so rapidly that there is a constant danger of one-sided outgrowth. It seemed useful to place in this review the extrinsic control of the endocrine system in the centre of interest. In doing so, stress is being laid on the function of the endocrine system as a mediator for long-term conditioning reactions. In this respect our paper, dedicated to the memory of the eminent ecologist Bodenheimer, is also a contribution to the knowledge of the physiological action of ecological factors.

ENDOCRINE FEEDBACK

The endocrine system of insects receives messages of both internal and external origin. We will first discuss the internal milieu, and start with the information the endocrine system receives from its own target organs. This endocrine feed-back has been studied best in the regulation of oögenesis. It is integrated with other modifying influences by the brain by means of the neurosecretory cells (Figure 1).

Stimuli from the brain to the corpora allata may be either reflectory or neurosecretory. The existing evidence favours the supposition that the reflectory influence is either trophic or inhibitory, while stimulation is brought about along the neurosecretory pathway. It may well be that part of the activity of the corpus allatum exists in transmitting substances present in neurosecretory material (Ichikawa 1959, Gilbert & Schneidermann 1959).

Received July 24, 1960.

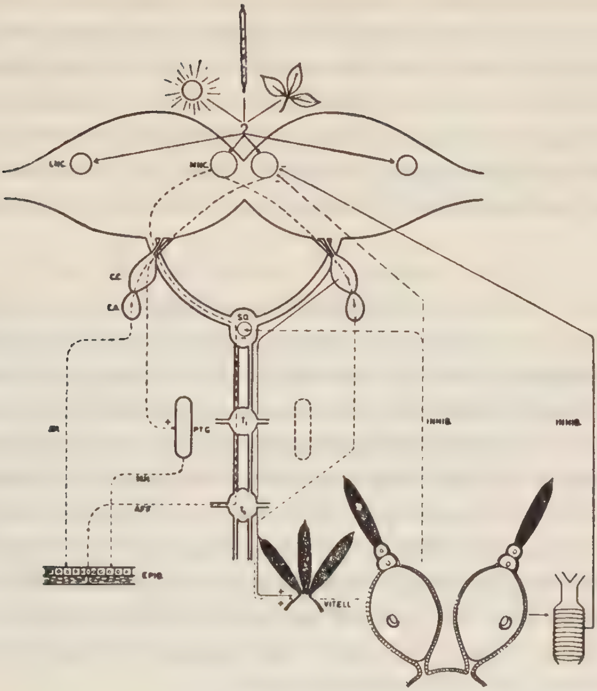


Figure 1

Endocrine regulation of moulting and egg formation, including some pathways of endocrine feedback.

mnc = median neurosecretory cells
ca = corpora allata
cc = corpora cardiaca
ptg = prothoracic gland
aff = afferent stimuli
jh = juvenile hormone
mh = moulting hormone

Thomsen (1942), Vogt (1942), Day (1943), Kaiser (1949) and von Harnack and harrer (1955) have observed in several insect species that ovariectomy is followed an abnormal enlargement of the corpora allata. This points to an inhibitory effect the growing ovaries on the corpora allata. Experiments by von Harnack and harrer (1956) with *Leucophaea* and by Nayar (1958) with the bug *Iphita* have ade it probable (though not certain) that this restraining influence takes place by ay of the brain, and consists of a humoral effect of the ovary on the pars inter-rebralis.

Many interactions between endocrine glands and reproductive organs have been und in roaches. In *Diploptera punctata*, a viviparous roach, mating appears to move the inhibitory effect of the brain on the corpora allata, which is essential a normal rate of egg growth. This occurs along the reflectory pathway. Complete

inhibition of the corpora allata, and thus of the ovaries occurs during pregnancy and is achieved by eggs developing in the brood sac (Engelmann 1959).

In the ovoviviparous roach *Leucophaea maderae*, the corpora allata are inhibite during pregnancy by the oötheca in the brood sac. This inhibition is reflectory an occurs via the brain. Activation of the corpus allatum only occurs if the nervou connections between suboesophageal ganglion and corpora allata remain intact Thus, brain and suboesophageal ganglion act as antagonistic centres (Engelma 1957).

ENVIRONMENTAL CONTROL

Generally speaking, the impression is gained that the brain integrates the function of the endocrine system. We will now deal with the stimuli by which the centra releasing mechanism of endocrine functions is integrated into the environment

The environment exerts an extremely high selective pressure upon insect popu lations. This pressure as a rule is not constant but is subject to seasonal oscillation

The ecological factors involved are of a very diverse nature. Climate may b considered as the most basic factor ruling both plant and animal life. Seasona changes in plant life in their turn necessitate seasonal adaptations in plant-eatin insects. These again may form part of food chains with predators and parasites, fo the greatest part also insects. This means that seasonal rhythms in morphogenesi and reproduction are of great survival value.

In this respect we feel inclined to think in the first place of diapause. This pheno menon, which may occur in all stages, is inadequately described as a periodic stand still of growth and reproduction. In fact it is much more, the resting stage bein characterized by adaptive behaviour changes, special morphological structures an fundamental changes in metabolism, all directed towards conservation of wate and body reserves, and protection against extreme climatic conditions.

Diapause in larval and pupal stages and perhaps in embryons (Jones 1953) ma now be considered as an endocrine deficiency syndrome of the prothoracic gland which in their turn are under the control of the median neurosecretory cells.

As regards diapause in adult insects, until recently its endocrine origin has bee uncertain. During last years, in the Wageningen laboratory, we have been able t demonstrate that in the adult Colorado beetle, the complete syndrome of diapaus is produced upon surgical removal of the corpora allata. This includes standstill o reproduction, lowering of oxygen consumption to as little as 20% of the norma value, and a change in behaviour from feeding to burying. Reimplantation of activ corpora allata restores the reproductive condition.

Now it is clear from experiments by Ellen Thomsen (1952) and others that th corpora allata are under the control of the brain, and more especially the neurosecreto ry cells. It is again to these cells that we look for the primary causation of diapaus

To conclude my introduction, I might add some words on polymorphism. Th impression is often obtained that the prothoracic glands and corpora allata merel

act in releasing or inhibiting patterns of development which have been laid down in the insect in an early phase of embryonic development. These patterns may be cuticular structures or pigmentations. It seems likely, however, that within a given "inborn" pattern a certain degree of freedom has been left for the endocrine system to induce variations. This has been demonstrated for social polymorphism in termites by the recent work of Lüscher (1956). Joly (1956) and, in our laboratory, Staal, have shown it to be probable for morphological colour changes and social polymorphism in locusts.

Though the evidence in other cases is still scanty, it is perhaps not too daring to think that seasonal polymorphism might also be under the control of prothoracic glands and corpus allatum (Müller 1959).

Biologists have long considered the environment as acting more or less haphazardly on distinct physiological processes, food being concerned with metabolism, temperature with activity and light with orientation mechanisms. It has now become clear that ecological factors determining seasonal conditions mainly act via the central releasing mechanism of endocrine functions, i.e. through the neurosecretory cells, and by means of sign stimuli, correlated with the seasons.

We shall now follow step by step the means by which the endocrine regulation of morphogenesis, reproduction and behaviour is influenced by some important ecological factors.

Photoperiod

The photoperiod is a sign stimulus of remarkable qualities, controlling both diapause and seasonal polymorphism. It we compare the effect of different photoperiods, we generally observe a transition point, separating "long day" from "short day" (Figure 2). Accordingly, there are "long day" and "short day" insects. In the case of

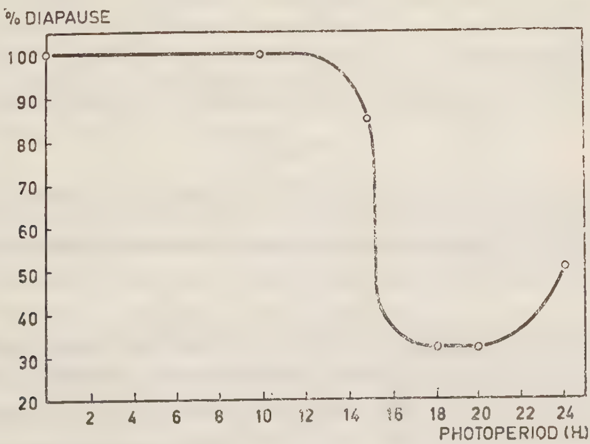


Figure 2

Percentage diapause as a function of the photoperiod in *Leptinotarsa* (de Wilde 1959).

photoperiod-induced diapause, the effect is in some cases reversible (Geyspit 1949) e.g. *Dendrolimus.* The receptive and effective stages may be the same, or ma be different, the extreme case being *Bombyx mori* L., where the egg is receptive bu only the eggs of the next generation go into diapause.

The existence of a sensitive stage rendeis improbable a direct connection betwee photoperiod and neurosecretion. In the Colorado bettle, for instance, larval growt proceeds at the same rate with 10 and 18 hour photoperiods, while in the adult 10 hour period prevents the corpora allata from becoming active.

Positive data as to the processes between photoperiod and neurosecretion ar extremely scanty. Removing or covering the photorecptors as has been done b Tanaka (1951) with silkworm larvae and by ourselves (1959) with adult Colprad beetles, has been without effect on the photoperiodic responses (Figure 3). It may we be that the photodynamic processes involved take place within the brain itsel the head capsule being more or less transparent, as has been suggested by Geyspit (1957).

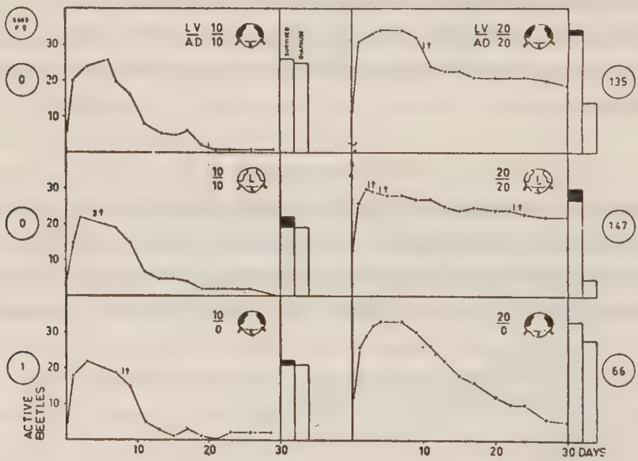


Figure 3

Capping the eyes with black paint does not prevent normal photoperiodic responses to occu in *Leptinotarsa* (de Wilde, 1959).
The numbers indicate the length of the photoperiod applied to larva and adult beetle. L = eye covered with black shellac.

Next comes the problem of the substances involved in the photo-chemical process Only Lees (1953) has made experiments allowing some conclusion as to the absorp tion spectrum of the pigments. His results point to the role of carotenoids as sensi bilizing pigments in the red spider mite *Metatetranychus ulmi* Koch. At this momen it seems premature to generalize as other authors have found wavelengths abov 600μ to be active in other insects (de Wilde and Bonga 1958) (Figure 4).

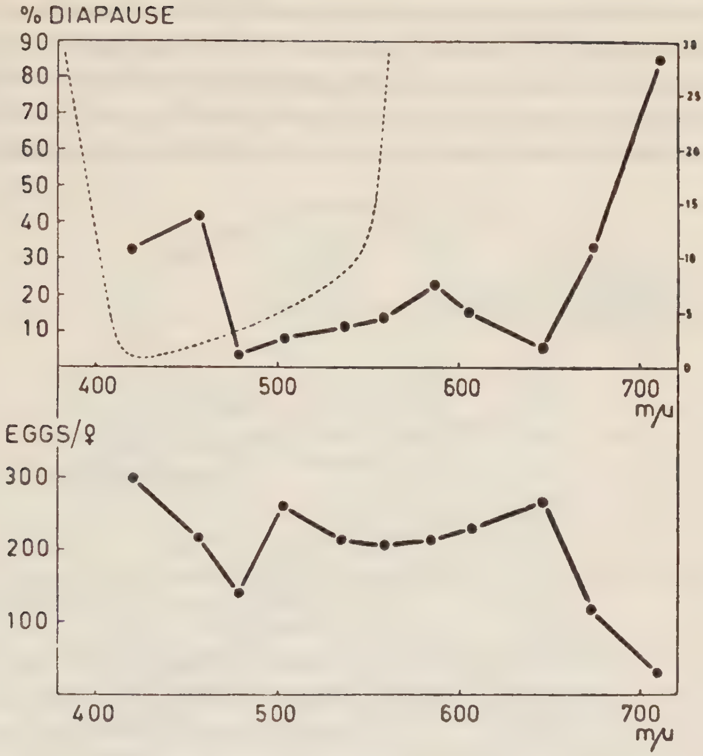


Figure 4

Effect of light of different wavelength in photoperiodic responses of *Metatetranychus* (Lees 1953) and *Leptinotarsa* (de Wilde and Bonga 1958)
........minimum radiation energy required to produce photoperiodic responses in *Metatetranychus*, as a function of wavelength.
•—•% of diapause (above) or egg production (below) as function of wavelength in *Leptinotarsa* exposed to an 18 hr. photoperiod.

Not the ratio, but the absolute value of both "light" and "dark" periods is of mportance, as is seen in the work of Danylievsky with *Acronycta rumicis*. Arthropods liffer from plants in that slow timing reactions take place both during light and lark periods. This point is most readily appreciated in experiments with "light reaks" during the dark period. For example, Dickson's (1949) results with *Graphoita* show that a light interval of 2 hours must be interpolated within a diapausenducing 12 hours dark phase before the incidence of diapause is materially reduced. n plants often a few minutes suffice.

Similarly, the light phase reaction in insects is little disturbed by short interpolated ntervals of darkness.

Temperature

Though temperature as such sometimes acts as a sign stimulus on endocri functions, it may especially do so in relation with photoperiod. We then obser that temperatures above a certain level counteract the short-day effect, promotir diapause in short-day and activity in long-day insects (Figure 5). It is shown tha especially the dark process is thermosensitive. Now the idea seems attractive that i

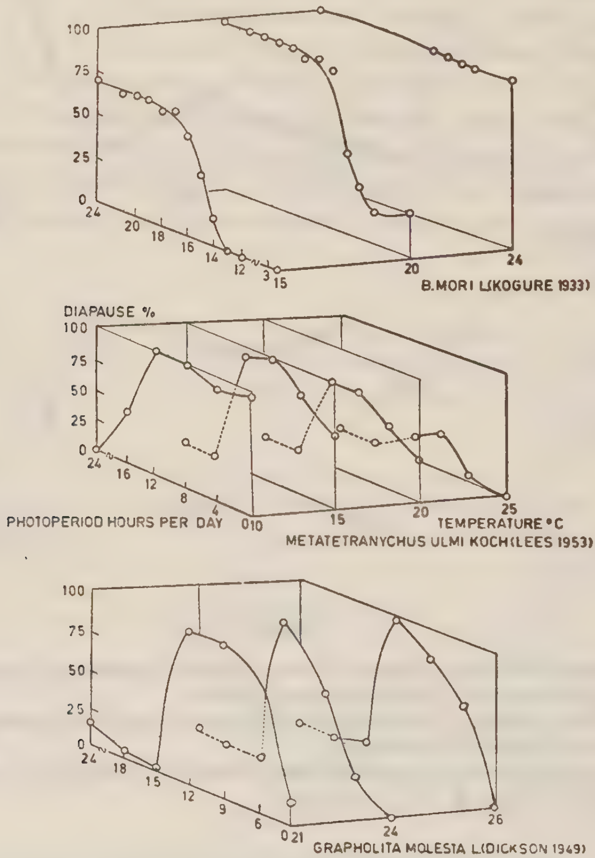


Figure 5

Effect of photoperiod and temperature on diapause in *Bombyx* (Kogure 1933), *Grapholi* (Dickson 1949) and *Metatetranychus* (Lees 1953).

short-day insects an inhibitory substance is formed by a photochemical proce during the light-phase, while in long-day insects an activating substance is forme both being removed by a chemical process during the dark phase. This would be i concert with the fact that in the short-day insect *Bombyx mori* L. diapause is broug about by an inhibitory hormone released by the suboesophageal ganglion.

But very probably this explanation is far too simple to account for the complicate

ituation which really exists here. For the suboesophageal ganglion only releases ts "diapause-hormone' when no longer kept in restraint by the brain. The "long lay" effect on the egg indeed does not become apparent until the last larval instar, vhere this inhibiting effect of the brain ceases (Figure 6). A "short day" effect on he egg results in keeping it intact. It is even this "remote control" of morphogenesis y environmental triggers which makes the problem most complicated.

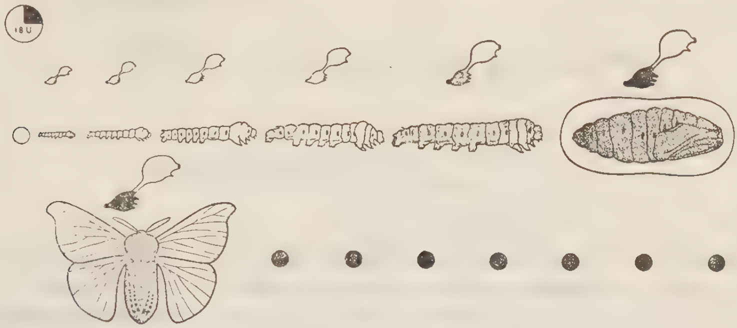


Figure 6

Sequence of events leading to diapause in *Bombyx mori* after exposure of the egg to "long day". Black points = "diapause factor".

We now come to the effect of temperature on the process which terminates diapause, process which has been given the name "diapause development" by the Austra-an ecologist Andrewartha.

Since Duclaux (1869) discovered the effect of chilling on break of diapause in ne silkworm egg, it has been recognized that low temperature, far from prolonging iapause, is in many instances a prerequisite for its termination. Such insects may emain quiescent for years if not subjected to cold. Next to these cases, there are uch where diapause development occurs without chilling but is accelerated by it.

The optimal temperature for break of diapause is not necessarily below the thresh-ld of development. It may be near 0 °C as in many Lepidopterous pupae, 0–15 °C for *Platysamia cecropia* and even 30 °C in the adult Colorado beetle. Our leas on the effect of chilling on break of diapause are much influenced by the onception of "acquisition of competence" as put forward by C.M. Williams (1956) his work with the pupa of *Platysamia cecropia*, a term which is perhaps synonymous ith "diapause development" (Figure 7).

In a series of most remarkable experiments, Williams and his collaborators (1946, 952, 1956) have been able to prove that during diapause the brain of this pupa physiologically inert. It is unable to stimulate the prothoracic gland. Moreover is electrically silent, its cholinesterase activity is almost reduced to zero, and an cetylcholine-like susbtance gradually accumulates.

If the pupa is chilled for 13 weeks or more at 6 °C, and thereafter returned to 25 °C, fter some days cholinesterase activity is restored, while at the same time the brain

is able to stimulate the prothoracic gland, suggesting that neurosecretory activit takes place (van der Kloot 1955).

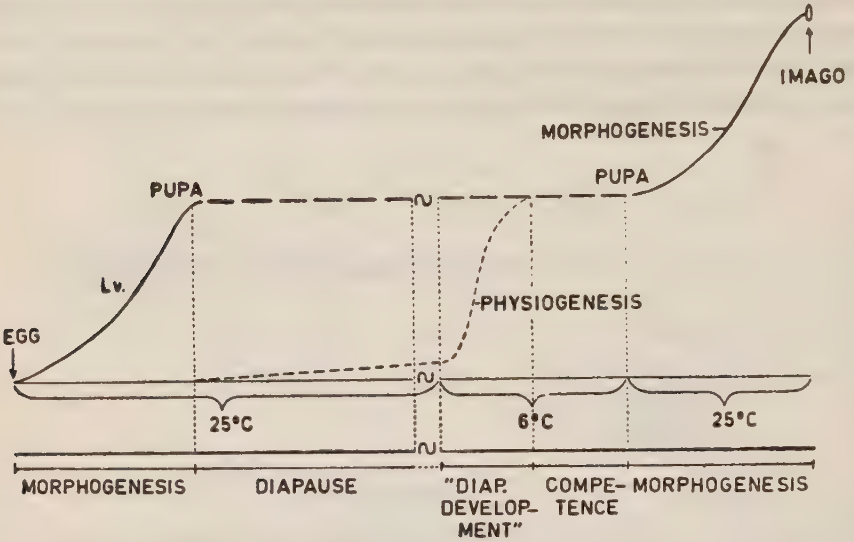


Figure 7

Graphical representation of morpho— and physiogenesis during the onset of diapause an its termination by chilling.

These experiments suggest that resumed nervous activity within the brain is a prerequisite to neurosecretion and it has even been suggested by Schneidermann (1956) that competence by chilling consists in aerobic synthesis of acetylcholine-lik substances.

It is here that the importance presents itself of combining physiological data wit histological evidence. The results again teach us prudence in premature generali zation.

Thus, it has been found histologically by Highnam (1958) that in the Hawkmot *Mimas tiliae* with an outspoken pupal diapause, neurosecretion in the brain start already during the first days of chilling at 3 °C, and even is entirely completed afte three weeks at this low temperature (Figure 8).

At the same time, the corpora allata show a remarkable increase in volume, whil the same is true for their individual cells. So it appears that this brain is not onl competent but completely active during the chilling period.

And even this case is not the most baffling, for in our laboratory, Schoonhove and Companjen have shown that in the univoltine Pine Looper, *Bupalus piniarius* with a pupal diapause, neurosecretion starts right after the pupal moult at norma temperatures, and a few days afterwards, the brain is no longer dispensable to adul development. But still, adult development in this pupa is clearly accelerated b chilling (Figure 9).

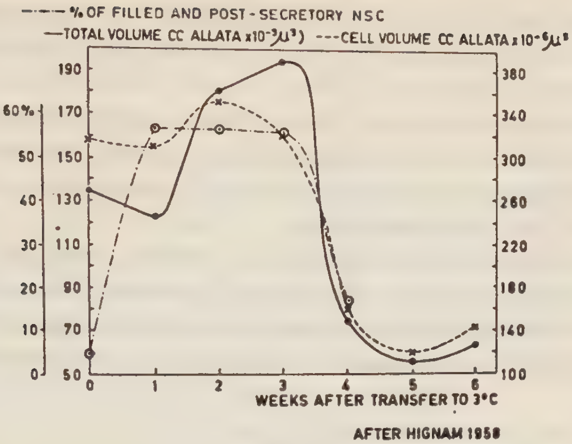


Figure 8

Activity of neurosecretory cells and size of corpora allata during chilling in the pupa of *Mimas tiliae* (Highnam 1958).

Figure 9

Neurosecretory activity in the brain and respiratory activity (O_2 uptake) in the diapausing pupa of three Lepidoptera species: *Hyalophora cecropia* (Williams), *Mimas tiliae* (Highnam), and *Bupalus piniarius* (Schoonhoven).

Similar observations have been made by Ozeki (1954) in the Swallowtail, *Papilio* *uthus*, and Rahm (1952) in *Sialis lutaria*, where it even seems that the brain is dis-ensible after the last larval instar!

We have indications in *Bupalus* that during chilling the prothoracic glands gradually ecome more and more active. It we compare the effect of various periods of chilling

on the number of weeks to initiate adult development at 25 °C in *Bupalus*, the graph obtained differs in an important way from that obtained by Williams (1956) with the Cecropia pupa.

Our curve shows two phases: one probably connected with the activation of the prothoracic gland and another with morphogenesis after this gland has been activated completely. This means that morphogenesis already starts at 3 °C and may even reach a high degree of completion.

Here we do not observe a sharp distinction between competence, activation and morphogenesis. It may be that the prothoracic gland itself is activated by chilling. It may also be that the release of neurosecretory substance by cc. cardiaca and/or cc. allata is blocked during diapause and that this block is removed by chilling.

Food

I should first like to emphasize that although the vitamin and amino acid requirements of many insect species have up until now been established, we know little about their specific effects on growth and reproduction. I think that it would be of great advantage if physiologists studying insect nutrition would stop looking only at mortality and time of survival, but instead would fix their attention to specific deficiency phenomena.

For, next to the quantitative effects of food on growth and reproduction, it has become clear that nutrition may also act as a "trigger" stimulus to the endocrine system.

Thus it has been shown by Bounhiol (1938) in his experiments with silkworm larvae that moulting only takes place after an obligatory nutrition period. Just what may be happening during such an obligatory feeding period has only been studied to some extent in the special case of the blood-sucking bug *Rhodnius prolixus*. Here it seems that as a result of the extensive blood meal, the abdominal wall is extended to such an extent as to stimulate the neurosecretory cells by way of the brain along the proprioceptive pathway (Wigglesworth 1934). The proprioceptors have been thought to exist in the abdominal musculature, but as this is only intact during the moulting process, this seems to be an improbable supposition. This type of self-controlled moult seems, moreover, to be a special case not valid in more continuous feeders, as are most phytophagous insects.

In larvae of the Colorado beetle, e.g., artificial distention of the abdominal wall by different means has up until now failed to reduce the normal intermoult period (Houx and de Wilde, unpublished). The quality of the food might play a more important role than has once been thought.

Much more conclusive data have been found on the effect of feeding on reproduction. In the adult Colorado beetle, reproduction only takes place in the event that the insects are fed upon young potato sprouts. Senescent leaves fail to maintain

ctivity; oviposition is stopped and the beetles enter diapause at a greater rate than ormal (Grison 1957, Jermy 1956).

The same happens if a continuous supply of young leaves is changed for a iscontinuous one, food being withheld for 10 hours per day or more. It has been iggested for many years that this effect takes place directly on the ovaries.

Recently however, Johansson (1958) has made experiments with the milkweed ug, *Oncopeltus fasciatus*, showing that another explanation is valid. *Oncopeltus* eeds separately on water and dry milkweed seeds. If females are fed on water or lucose solution, egg production is stopped short. This is not primarily caused by epletion of food reserves in the ovaries for, when such newly-starved females are rovided with two pairs of corpora allata of egg-laying females, oviposition occurs gain and lasts for several days at an almost normal rate.

Though the interference of the neurosecretory cells has not been proven in this ase, it is most probable that the inhibitory effect on the bug's own corpora allata ccurs by way of the brain. Thus, l ke mammals, starvation causes a state of gonado-ropic deficiency, which may be called here pseudo-allatectomy.

Host-Parasite relations

Parasites living in the haemocoel and competing for food with growing tissues nd organs of reproduction often appear to choose the endocrine pathway for in-ibitory effects. Thus, in the pupa of *Hyalophora cecropia*, the microsporidian *Nosema* pparently upsets the endocrine balance in the host and this leads to a repetition f structures at metamorphosis at the places where it invades the tissues (Finlayson 957).

The nematode *Sphaerularia bombi*, living in bumblebee queens, causes a parasitic astration by inhibiting growth and secretory activity of the corpora allata, either irectly or by way of the brain (Palm 1948).

Also in the parasitic castration of solitary bees of the genus *Andrena* by female arasites of the genus *Stylops*, the host's corpora allata are markedly reduced Brandenburg 1956).

The most remarkable phenomena in this respect, however, are the mechanisms ynchronizing the generations of insect parasites and their insect hosts. This syn-hronism is a condition for monophagous parasitism in interrupted generations. ynchronization generally requires a pacemaker, and either of the two partners, ost and parasite, can act as such.

A number of cases exist wherein the parasite larva remains within the host in a ormant state until it is activated by the latter. There are also cases wherein the para-ite inhibits the endocrine system of the host and takes over the control of its develop-ent.

One of the cases best studied is the parasitism of some Syrphid species by Ichneu-ionids of the genus *Diplazon* (Schneider 1951). In *D. fissorius* Grav, the first stage irva maintains the status quo within the syrphid larva until this enters pupation.

In the polyvoltine host *Epistrophe balteata*, it is polyvoltine; in the monovoltine *E. bifasciata* it is monovoltine (Figure 10). Immediately after the formation of the host's puparium, the parasite starts feeding and secreting saliva, thereby killing and histolyzing the host's tissues.

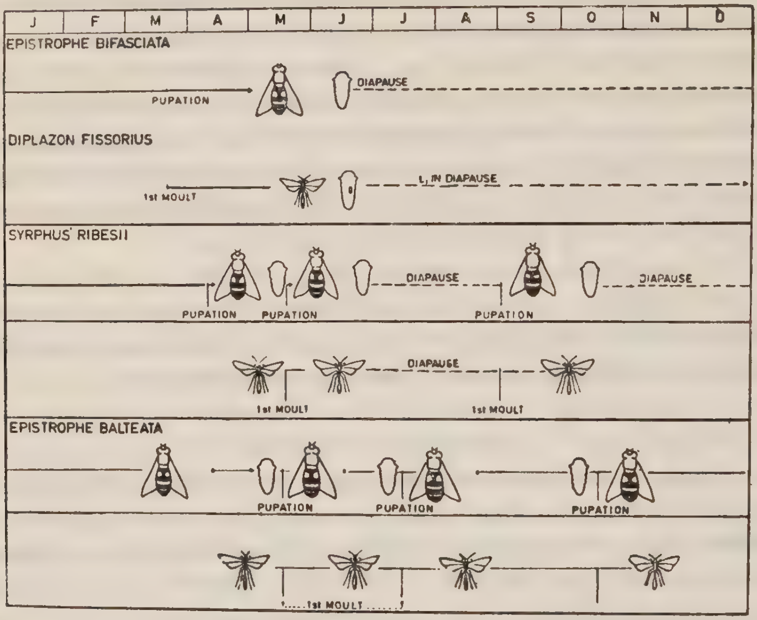


Figure 10

Life cycle of the Ichneumonid *Diplason fisssorius* in three different hosts (Schneider 1950),

On the other hand, if the same hosts are parasitized by the related Ichneumoni *D. pectoratorius*, the order of events is quite different. The parasite larva immediatel starts feeding and secreting saliva, thus damaging the host's brain and imagina discs. The host, thus having lost its endocrine autonomy, stays in a condition c quiescence until the parasite is activated by autumnal low temperatures. It subse quently induces puparium format on in its host, and starts histolyzing it before i can develop further. Especially in the last case, it is striking that the parasite hit exactly the superordinated centre of endocrine functions (Figure 11).

Other striking cases of synchronism occur with many Tachinid flies.

An example well studied from the ecologica point of view is the relation betwee *Eucarcelia rutilla* Zett. and some Geometrid moths. According to Klomp's obse vations. this fly is bivoltine in bivoltine hosts and monovoltine in the monovoltin Pine Looper, *Bupalus piniarius* L. Synchronism even goes so far that *Eucarceli* adults emerging from male *Bupalus* pupae appear a few days earlier than thos developing in female hosts. This coincides with the fact that emergence of *Bupalu* is protandric (Klomp 1956).

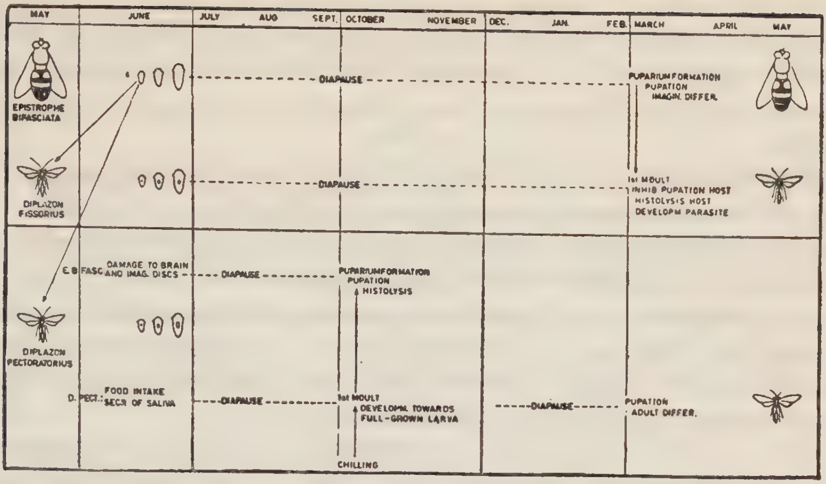


Figure 11
Life cycle of two *Diplazon* species in *Epistrophe balteata* and their effect on host development (Schneider 1951).

In our laboratory, Schoonhoven has studied the problem as to whether the larva of *Eucarcelia* has lost control of its endocrine system, it being activated by the host's hormones before the adult moult. This seemed in accord with the fact that in early decerebrated, parasitized hosts, without chilling, host and parasite remain in permanent diapause. However if the larva is chilled to 3 °C for a sufficient time, within its decerebrated host pupa, things are different. In this case the larva develops within a few weeks after being returned to 25 °C.

So it seems that the larva has its own endocrine autonomy, but nevertheless the host may act as a pacemaker. Whether it does so by inhibitory or activating messages, remains to be studied.

Control of social polymorphism

It is known that in social insects the development of casts is a feature of highly-organized colony formation. Perhaps most striking in this respect are the termites, where both sexes may develop into workers, soldiers, pseudergates and the reproductive queen and king.

In non-reproductive casts of *Kalotermes flavicollis* (Fabr.), the development of the gonads is suppressed by the action of a pheromon, a substance emerging from the reproductive cast (queen and king).

This seems to be independent of the corpora allata. The development of soldiers, however, is in this species under the influence of the corpus allatum and may be caused artificially by implanting extra corpora allata obtained from newly moulted supplementary reproductives into nymphs. This should be done from 5 to 7 days before the moulting hormone of the prothoracic gland is secreted (Luscher 1956, 1958).

In conclusion, I may say some words on phase formation in locusts. Many species

of migratory locusts are extremely polymorphic. Their pigmentation, morphological dimensions and types of behaviour strongly depend upon the density of the locust population while still in the hopper stage. These density effects depend primarily upon visual perception. The morphs thus produced are known as phases; gregarious and solitary.

The endocrinological approach to the problem of phase formation has been begun by Joly (1956) and has been followed in extent by Staal in our laboratory.

I will mainly deal with the African migratory locust, *Locusta migratoria migratorioïdes* R & F. The gregarious larva shows "pattern"; the solitary larva is green when reared under humid conditions, but has a wide morphological colour adaptation when reared dry. The gregarious adult is yellow in the mature male, the solitary adult green under humid conditions. The index wing length/femur length, is smaller in the solitary than in the gregarious adult.

Let us now first turn to the green pigmentation. As Joly (1956) has first shown, this may be brought about by implantation of extra corpora allata. This has been confirmed by Staal, who has produced the effect throughout the complete larval range.

In extirpation experiments, the difficulty is to differentiate between the "juvenile hormone" effect of the corpus allatum and its effect on pigmentation.

It is known that denervation of the corpus allatum often enhances its activity. In *Locusta migratoria* this operation does not induce green pigmentation. Moreover, it interferes with larval development and adultoids are formed after a delay of some stages.

Implantation of extra corpora allata in L_5 at successive times after the last larval moult has different effects: early implantation gives juvenile features (green nymphoid adults); late implantation causes only the green pigment to be formed.

After allatectomy, the next moult is generally an adult moult. These adults, however, never become yellow in the male sex. After implantation of corpora allata, the yellow pigment is formed.

Thus, extra corpora allata implanted in the larva produce a solitary feature (green), while in the adult male they produce a gregarious feature (yellow).

Implantation of extra prothoracic glands in the young (L_2) nymph results in morphological abnormalities, such as increased wing length, which is again a gregarious feature. Furthermore, implantation of extra corpora cardiaca in green solitary nymphs results in an increase of melanin pattern, the background remaining green.

It follows from these experiments that a number of important phase characteristics is under the influence of the endocrine system. Further experiments are needed before we may decide whether the whole phase syndrome originates in the endocrine balance.

Nature has endowed the insects with a system controlling growth, form and reproduction. This system is integrated into the environment sometimes by means of "sign" stimuli, sometimes by being affected directly and sometimes in its turn controlling other insects.

Indeed, the extrinsic control of endocrine functions truly represents the complexity of the "Umwelt", and shows again that animal and environment are a unity.

REFERENCES

BOUNHIOL, J.J., 1938, Recherches expérimentales sur le déterminisme de la métamorphose chez les Lépidopteres, *Bull. Biol. Fr. Belg.*, **24**, 1–199.

BRANDENBURG, J., 1956, Das endokrine System des Kopfes von *Andrena vaga* Pz. (Ins. Hymenopt.) und Wirkung der Stylopisation (*Stylops*, Ins, Strepsipt.) *Z. Morph. Okol. Tiere*, **45**, 343–364.

DAY, M.F., 1943, The function of the corpus allatum in Muscoid Diptera, *Biol. Bull. Woods Hole*, **84**, 127–140.

DICKSON, R.C., 1949, Factors governing the induction of diapause in the oriental fruit moth, *Ann. Ent. Soc. Amer.*, **42**, 511–537.

DUCLAUX, M.E., 1869, De l'influence du froid de l'hiver sur le développement de l'embryon du ver à soie, et sur l'éclosion de la graine, *C.R. Acad. Sci.*, Paris, **79**, 1021.

ENGELMANN, F., 1957, Die Steuerung der Ovarfunktion bei der Ovoviviparen schabe *Leucophaea maderae* (Fabr.), *J. Ins. Physiol.*, **1**, 257–278.

ENGELMANN, F., 1959, The control of reproduction in *Diploptera punctata* (Blattaria), *Biol. bull.*, **116**, 406–419.

FINLAYSON, L.H. AND V. ANN WALTERS, 1957, Abnormal metamorphosis in Saturniid moths infected by a Microsporidian, *Nature*, Lond., **180**, 713–714.

GEYSPITZ, K.F., 1949, Light as a factor regulating the cycle of development of the pine Lasiocampid *Dendrolimus pini* L. (Russian), *C.R. acad. Sci. U.S.S.R.*, **68**, 781.

GEYSPITZ, K.F., 1957, On the mechanism of light stimuli perception during photoperiodic reaction in caterpillars of Lepidoptera (Russian), *Zool. J.*, **36**, 548–559.

GILBERT, L.I. AND SCHNEIDERMAN, H.A., 1959, Prothoracic gland stimulation by juvenile hormone extracts of insects, *Nature*, Lond., **184**, 171–173.

GRISON, P., 1957, Les facteurs alimentaires de la fécondité chez le Doryphore (*Leptinotarsa decemlineata* Say) (Col. Chrysomelidae), *Ann. épiphyties*, **3**, 304–381.

HARNACK, M. V. AND SCHARRER, B., 1956, A study of the corpora allata of gonadectomized *Leucophaea maderae* (Blattaria), *Anat. Rec.*, **125**, 558.

HIGHNAM, K.C., 1958, Activity of the brain/corpora cardiaca system during pupal diapause "break" in *Mimas tiliae* (Lepidoptera), *Quart. J. micr. Sci.*, **99**, (1), 73–88.

ISHIKAWA, M. AND NISHIITSUTSUJI-UWO, J., 1959, Studies on the role of the corpus allatum in the Eri-silkworm, *Philosamia cynthia ricini*, *Biol. Bull.*, **116**, 88–94.

JERMY, T. UND SARINGER, G., 1955, Die Rolle der Photoperiode in der Auslösung der Diapause des Kartoffelkäfers (*Leptinotarsa decemlineata* Say) und des amerikanischen weissen Bärenspinners (*Hyphantria cunea* Drury), *Acta agr. Acad. Sci. Hungaricae*, **5**, 419–440.

JOHANSSON, A.S., 1958, Relation of nutrition to endocrine reproductive functions in the milkweed bug *Oncopeltus fasciatus* (Dallas) (Heteroptera: Lygaeidae), *Nytt Magasin for Zoologi*, **7**, 1–132.

JOLY, P., JOLY L. AND HALBWACHS, M., 1956, Contrôle humoral du developpement chez *Locusta migratoria*, *Ann. Sci. nat. Zool. Biol. anim.*, **18**.

JONES, B.M., 1953, Activity of the incretory centres of *Locustana pardalina* during embryogenesis: Function of the prothoracic glands, *Nature*, Lond., **172**, 551.

KLOMP, H., 1956, Die morphologischen Merkmale und die Bionomie der Kiefernspanner Tachine *Carcelia obesa* Zett., *Z. angew. Ent.*, **38**, 288–294.

KAISER, P., 1949, Histologische Untersuchungen über die *Corpora allata* und prothoracicdrüsen der Lepidopteren in Bezug auf ihre Funktion, *Arch. Entw. Mech.*, **144**, 99–131.

KLOOT, W.G. VAN DER, 1955, Control of neurosecretion and diapause by physiological changes in the brain of the Cecropia silkworm, *Biol. Bull.*, **109**, 276–294.

LEES, A.D., 1953, The significance of light and dark phases in the photoperiodic control of diapause in *Metatetranychus ulmi* Koch, *Ann. appl. Biol.*, **40**, 487–497.

LÜSCHER, M., 1956, Hemmende und fördernde Faktoren bei der Entstehung der Ersatzgeslechtstiere bei der Termite *Kalotermes flavicollis* Fabr., *Revue Suisse de Zool.*, **63**, 261–267.

LUESCHER, M., 1958, Uber die Entstehung der Soldaten bei Termiten, *Revue Suisse de Zool.*, **65**, 372–377.

MÜLLER, H.J., 1959, Tageslänge als Regulator des Gestaltwandels bei Insekten, *Die Umschau*, **2**, 36–39.

NAYAR, K.K., 1958, Probable endocrine mechanism controlling oviposition in the insect *Iphita limbata* Stal., *2nd Int. Symp. Neurosecretion*, 102–104.

OZEKI, K., 1954, Experiments on the formation of imaginal structures in the pupae of the swallowtail, *Papilio xuthus* L., *Sci. Pap. Coll. Gen. Ed.*, Tokyo, **4**, 47–56.

PALM, N.B., 1948, Normal and pathological histology of the ovaries in *Bombus* Latr. (Hymenopt.), *Opuscula Ent.*, Suppl. VII.

RAHM, U.H., 1952, Die innersekretorische Steuerung der postembryonalen Entwicklung von *Sialis lutaria* L. (Megaloptera), *Revue Suisse Zool.*, **59**, 172–237.

SCHNEIDER, F., 1951, Einige physiologische Beziehungen zwischen Syrphidenlarven und ihren Parasiten, *Z. angew Ent.*, **33**, 150–162.

SCHNEIDERMAN, H.A., 1956, Onset and termination of insect diapause, *Physiol. Triggers*, 46–59.

TANAKA, Y., 1951, Studies on hibernation with special reference to photo-periodicity and breeding of the Chinese tussar-silkworm (Japanese) V., *J. Seric. Sci. Japan*, **20**, 132.

THOMSEN, E., 1942, An experimental and anatomical study of the corpus allatum in the blowfly *Calliphora erythrocephala* Meig., *Vid. Med. Dansk Nat. hist. For.*, **106**, 320–405.

THOMSEN, E., 1952, Functional significance of the neurosecretory brain cells and the corpus cardiacum in the female blow-fly, *Calliphora erythrocephala* Meig., *J. exp. Biol.*, **29**, 137–172.

VOGT, M., 1943, Zur Kenntnis des larvalen und pupalen corpus allatum von *Calliphora*, *Biol. Zbl.* **63**, 56–71.

WIGGLESWORTH, V.B., 1934, The physiology of ecdysis in *Rhodnius prolixus* (Hemiptera). II. Factors controlling moulting and metamorphosis, *Quart. J. micr. Sci.*, **77**, 191–222.

WILDE, J. DE AND BONGA, H., 1958, Observations on threshold intensity and sensitivity to different wavelengths of photoperiodic responses in the Colorado beetle (*Leptinotarsa decemlineata* Say), *Ent. exp. appl.*, **1**, 301–307.

WILDE, J. DE, DUINTJER, C.S. AND MOOK, L., 1959, Physiology of diapause in the adult Colorado beetls. I. The photoperiod as a controlling factor, *J. ins. Physicol.*, **3**, 75–85.

WILDE, J. DE, 1960, Diapause in the Colorado beetle (*Leptinotarsa decemlineata* Say) as an endocrine deficiency syndrome of the corpora allata, *Proc. Int. Symp. Ontogen. Dev. Insects*, (in print).

WILLIAMS., C.M., 1946, Physiology of insect diapause: The role of the brain in the production and termination of pupal dormancy in the giant silkworm, *Platysamia cecropia*, *Biol. Bull.*, **90**, 234–243.

WILLIAMS, C.M., 1952, Physiology of insect diapause. IV. The brain and prothoracic glands as an endocrine system in the Cecropia silkworm, *Biol. Bull.*, **103**, 120–138.

WILLIAMS, C.M., 1956. Physiology of insect diapause. X. An endocrine mechanism for the influence of temperature on the diapausing pupa of the cecropia silkworm, *Biol. Bull.*, **110**, 201–218.

NOTES ON THE ECOLOGY OF IXODID TICKS OF DOMESTIC STOCK IN ISRAEL*

B. Feldman-Muhsam
Department of Parasitology, The Hebrew University of Jerusalem
and
I.M. Saturen
U.S. Department of Agriculture, ARS, Animal Disease Eradication Division, Union Stock Yards, Lancaster, Pa.

There is no need to stress the importance of surveying the tick fauna of a country in which various diseases of domestic stock are known to be transmitted by ticks.

During the last 30 years two such surveys were undertaken. One was carried out during 1928–1930 by the Department of Agriculture of the British mandatory administration. A great many ticks from various animals were collected from all parts of Palestine by the veterinary officers and other members of the field staff of that Department. A second much more modest survey was carried out by one of us (I.S.) during 1950 within the boundaries of Israel.

This survey was performed single handed and owing to other limitations of a technical and financial nature, possibilities were restricted. Nevertheless an attempt was made to obtain information regarding a wide range of hosts as well as seasonal and local distribution.

Of the collection made during the Mandate all *Rhipicephalus* [*R. sanguineus* s.str. (Latreille, 1806), *R. secundus* Feldman-Muhsam, 1952 and *R. bursa* Canestrini and Fanzago, 1877], *Haemaphysalis* and *Ixodes* were diagnosed, and seasonal and geographical distributions analysed (Feldman-Muhsam 1951, 1952, 1953a, 1954b, 1955).

This note is an attempt to evaluate the findings of the second survey, but data from the first have also been used whenever they could add significant information. The host preferences of the various ticks will be described and some attention given to the part of the body to which they are generally attached. Seasonal variations in the number of ticks of various genera will be discussed only qualitatively. The sex ratio on the host in each of the genera proved to be of considerable ecological interest. The geographical distribution of the various genera was not considered

* The field work of the present study was supported by the Research Council of Israel, and the elaboration of the material by Research Grant No. R.G. 4531 of the National Institutes of Health, U.S. Public Health Service.

Received March 22, 1961

worthy of special attention because, with the exception of *Ixodes*, most of tl thrive in all parts of the country.

Hyalomma

The genus *Hyalomma* is represented in Israel mainly by *Hyalomma excava* Koch, 1844 and probably more than 95% of *Hyalomma* ticks in the country, pa cularly on cattle, are *H. excavatum*. This species is frequently found on other dome stock such as camels, donkeys, horses, mules and sheep. Camels are also regul parasitised by *H. dromedarii* K., 1844 while two other species, which are specific the camel, *H. schulzei* Olenev, 1931 and *H. impeltatum* Sc & Schl., 1929 are m rarer. None of the other species of *Hyalomma* prevalent rema — *H. margina* K., 1844 *H. detritum* Sch., 1919 *H. rufipes* K., 1844 and *H. glabrum* Delpy, 194 is nearly as abundant as *H. excavatum*; they are all found on a variety of hosts inc ing domestic stock and wild animals.

Hyalomma excavatum is found on cattle throughout the country, in all mo of the year (Figure 1). During the coldest months December and January, ticks scarce. In March the number of adults found on cattle rises considerably, and f April–May onward huge numbers cover the cattle. *Hyalomma* ticks generally at themselves to the hindquarters, i.e., inguinal region, inner side of hind legs, ud belly and anus. We have never found *Hyalomma* attached to the head or ears (n than 800 cows examined).

The number of males attached to cattle is generally larger than that of fem but considerable variations in the sex-ratio were observed in the course of the y

In order to explain variations in the ratio of males to females on the host, sev facts should be taken into consideration.

1) From laboratory rearings we know that at emergence the sex-ratio betw males and females (in *Hyalomma* as well as in *Rhipicephalus*) is 1 : 1.

2) Laboratory experiments prove that males remain attached to the hosts m longer than females. Females leave the host immediately after engorgement, days after ascending it; while males remain on it for a long and variable pe In one instance when *H. dromaderii* fed on white rats, the females engorged i days whereas the males were scratched off only accidentaly together with the ban holding the feeding box, after 40 days. It is obvious that if the sex-ratio at emerg is 1 : 1, the sex-ratio on the host equals the ratio of the duration of the meal o male to that of the female; thus, for example, if the male remains three times lo on the host than the female, there will be roughly three times as many males as fen on the host.

3) During examination of the host it is much easier to find the relatively l gorged and semi-gorged females than the small males.

4) From laboratory experiments on hibernation of *Hyalomma excavatum* known that both the engorged nymphs and the unengorged imagines success withstand winter conditions in Israel (Feldman-Muhsam 1949). It may therefo

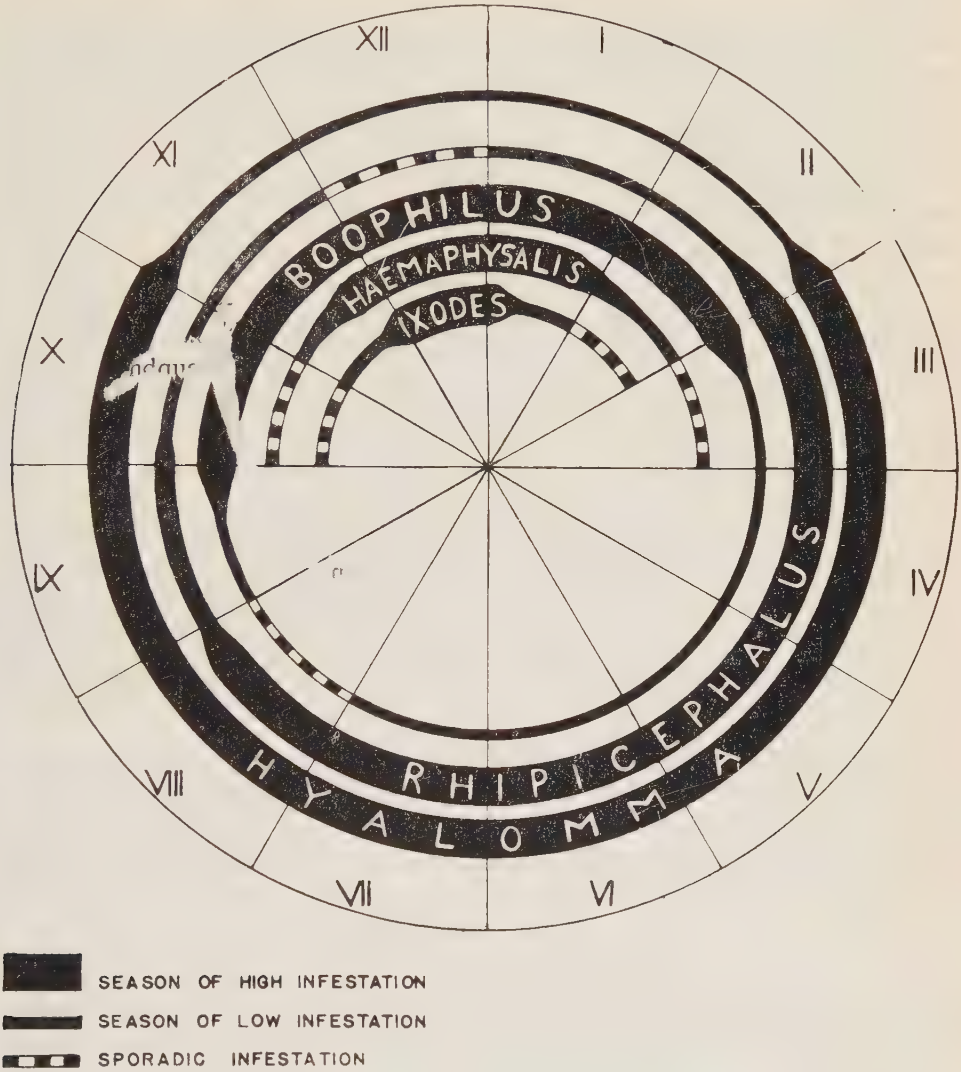


Figure 1
The seasonal infestation of *Hyalomma*, *Rhipicephalus*, *Boophilus*, *Haemaphysalis* and *Ixodes*. The arrangement from the periphery to the centre corresponds to the order of importance as pest of live-stock.

assumed that hibernation occurs at these stages. As the nymphs may hibernate at places with widely different micro-climates, emergence may occur over a long period from March to June. Such a wide range was observed in laboratory experiments on hibernation where the earliest emergences (at room temperature) occurred in mid-March and the latest (out of doors in a shady place) in mid-June.

During the 9 months July to March, there are about 1.5–2 times more males

than females on the hosts. This is easily understood because males feed much longer than females. During March, the proportion of females begins to rise and in April their number equals that of males. This can be explained by the fact that during spring huge numbers of unfed adults ascend the hosts. Since among these, the sexes are probably in equilibrium, the sex-ratio on the host approaches 1 : 1. Durring May–June the number of females taken off the host exceeds that of males by 13–20%. This difference may reflect nothing but the fact that because of their larger size the gorged and semi-gorged females are more easily found, and therefore abound in the collection. In July the males are three times more plentiful than females. This is due to the fact that by July all f[illegible]s of the spring wave have already descended from the host after engorgement whereas many of the males still remain attached. Owing to the difference in the duration of the attachm[illegible] from July onward until the next spring, the number of males remains well above that of fema[illegible] The total number of *Hyalomma* ticks taken off cattle during the whole year was 3517 males and 2489 females.

Hyalomma ticks also parasitize sheep but only in small numbers. During a whole year only 232 males and 146 females were found on about 900 sheep. Here again as in cattle, during the month of May the number of females was larger than that of males (50 : 31). During all other months the number of males greatly exceeded that of females. On sheep, *Hyalomma* ticks attach themselves mainly to the fat tail (all the sheep are of the fat-tailed breed) and sometimes to the udder, but never to the ears, head or neck.

Hyalomma ticks are only accidental parasites of goats. From a year's inspection of more than 200 goats only 16 females and 15 males were collected. These were found only during the summer months when the number of *Hyalomma* is at its peak.

Many nymphs and some larvae of *Hyalomma* were found feeding on cattle and camels.

RHIPICEPHALUS

The genus *Rhipicephalus* is represented in Israel by *Rhipicephalus secundus* Fel. Muh., 1952, *Rhipicephalus sanguineus* Lat., 1806 and *Rhipicephalus bursa* Can. & Fan., 1877. Feldman-Muhsam (1956) showed that in Israel of the *R. sanguineus* s.l. population parasitizing goats, sheep and cattle, 91, 94 and 97% respectively are *R. secundus*, and the remainder — *R. sanguineus*, s. str., whereas on dogs 81% are *R. sanguineus* s.str. and 19% *R. secundus.*

R. secundus is found on cattle during the hot months of the year. The ticks begin to appear on the cattle in large numbers in March and, during the winter months October–January, they are found only sporadically. During one year's inspection 1134 females and 789 males were found on cattle. Except during the peak months the number of males taken off cattle approximately equals that of females, but beginning from March the number of females increases considerably in porportion to males, until in May, the ratio reaches 2 females: 1 male.

As with *Hyalcmma*, *Rhipicephalus* males remain attached to their host much longer than females. In the laboratory, females engorged on their hosts in 6–14 days, while the males in the same experiments remained attached for 6–79 days. Even though males remain attached so much longer to their hosts than the females, ca. 44% more females than males were taken off cattle during the whole year. The only explanation is that the males escape the searcher's eye because of their small size in comparison with that of the engorged, or partly engorged, females. That this is true will be corroborated below by the experience with other genera: the smaller the males, the higher the proportion of females collected from hosts.

In contrast to *Hyalomma*, *Rhipicephalus* ticks attach themselves to the ears as well as to the hindquarters of cattle. However, they prefer the hindquarters in the proportion of 4 : 1. In sheep they mainly attach themselves to the ears and only rarely to the hindquarters.

As with the sex-ratio observed in *Hyalomma*, on its preferred host (cattle), taking the year as a whole, more males than females of *Rhipicephalus* were removed from the main host (sheep), (see table I). In January and February the number of males is double that of females and during the subsequent months, when the new generation of ticks ascends the host, the proportion of females increases until the sexes are roughly even about May. *Rhipicephalus* are found on sheep throughout the year; in large numbers during spring and summer, and small numbers during winter (Figure 1).

Rhipicephalus prefers sheep to cattle: for the same year we found about 3000 *Rhipicephalus* on sheep, as compared with 923 on cattle (Table I). The goat is also a favoured host of *Rhipicephalus secundus*, where it is primarily found on the ears and rarely, on the posterior part of the body. As with sheep, only during the month of May are more females than males found on the goat. During all other months the males outnumber the females. *R. secundus* also occurrs on horse, donkey, mule, jackal, hedgehog and dog, and is found in all parts of the country.

Rhipicephalus sanguineus s.str. is primarily a parasite of dogs. It is a three-host tick. The larvae and nymphs feed on dogs and on small mammals. Adults of *R. sanguineus* s.str. attach themselves mainly to ears of dogs. The same is true for larvae and nymphs, but these stages are also found around the eyes and near the mouth. A similar pattern of preference of various stages for different parts of the body of the host has been found by MacLeod (1939) and Milne (1947) for *Ixodes ricinus* parasitizing sheep in England.

In hilly regions of Israel ticks are not found on dogs during the winter months, which are relatively cold; in the coastal plains, the adults are found during the whole year. 552 males and 385 females were removed from dogs during the year. These figures are much smaller than those for *R. secundus* but it should be pointed out that far fewer dogs were examined than cattle, sheep and goats; because dogs are much less plentiful in the country than domestic stock. During the summer and autumn

dogs are heavily covered with larvae and nymphs. There are probably two generations a year.

R. sanguineus s.str. is an accidental parasite of cattle, sheep and goats: and may also be found on horse, donkey, jackal and hedgehog.

R. bursa is a two-host tick which is not very common in Israel. It was found to constitute about 1% of the *Rhipicephalus* population in the country (Feldman-Muhsam 1953b). The adults as well as the preimaginal stages parasitise sheep and goats. A few adults were found on cattle. The adults attach themselves to the head and ears as well as to the posterior part of the body. The larvae and nymphs were always found attached to the deepest parts of the ear-canal, and could not be found on the host until we discovered their particular site of attachment. It is interesting to note in this connection that neither Pavlovskii and Pomeranzev (1934) nor Daubney and Hudson (1934) succeeded in feeding the preimaginal stages of *R. bursa* on sheep. The preimaginal stages are found on their hosts during the winter months (November to April), and the adults during the summer (May to November). Sergent et al. (1945) state, on the other hand, that in Algeria *R. bursa* hibernates as nymph from autumn to the end of spring.

BOOPHILUS

The great majority of *Boophilus* ticks in Israel is *B. annulatus* Say, 1821 which parasitises cattle, sheep, goats, horses, donkeys, mules, camels and dogs. A few *B. kohlsi* Hoogstraal and Kaiser, 1960 have been found on goats and sheep.

Boophilids are present on their hosts throughout the year, but they are mainly winter ticks (Figure 1).They can be found in large numbers on their hosts from October to the end of February; but during the rest of the year they occur in small numbers. In August they are very rare. They are generally found on the hindquarters of cattle, but if infestation is heavy they crowd along the back. We never found them on the ears of cattle. Five to six times more females than males were collected from the hosts (Table I). This is surprising in view of Hitchcock's (1955) observation that in Australia, the engorged females of *B. microplus* Canestrini, 1877 commenced to fall off cattle 19 days after the attachment of the larvae, while males were still present up to 70 days. It is true that this observation relates to *B. microplus* and not

TABLE I

The number of ticks collected during the year 1950, *classified by sex, genus and host*

	Hyalomma		*Rhipicephalus*		*Boophilus*		*Haemaphysalis*		*Ixodes*	
Host	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
Cattle	3517	2489	789	1134	244	807	27	46	—	—
Sheep	232	146	1712	1287	2	82	122	86	6	50
Goats	15	16	622	554	—	50	101	88	2	41
Dogs	—	—	552	385	7	52	5	16	—	—

to *B. annulatus* with which we are concerned here, but we did not find in the literature any data on the duration of attachment of *B. annulatus* to their hosts. We therefore think that the low proportion of males in our collection should be ascribed to their very small size.

HAEMAPHYSALIS

Haemaphysalis species prevalent in Israel on domestic stock are *H. otophilia* Sch., 1918 and *H. cretica* Senevet and Caminopetros, 1936 (Feldman-Muhsam 1951). *H. taurica* Pospelova-Shtrom, 1918 (for systematic position of this species see Feldman-Muhsam 1953a) feeds on the hedgehog and *H. adleri* Feldman-Muhsam, 1951 is mainly found on the jackal and other carnivores (Costa 1958).

Both *H. cretica* and *H. otophila* have been found on cattle, sheep, goat and camel. Adult *Haemaphysalis* ticks are found on their hosts during the cold months, from November to February. A few can be found in October and March. Haemaphysalids have not been found to be as abundant as *Hyalomma* or *Rhipicephalus*, or even *Boophilus*.

We have already shown (1951) that within the boundaries of what was known as mandatory Palestine, *H. otophila* is much more abundant than *H. cretica*. Among domestic stock *H. otophila* and *H. cretica* prefer sheep and goats. *H. otophila* apparently has a marked preference for sheep. Whereas on sheep, 74% of Haemaphysalids are *H. otophila* and 26% *H. cretica*; on goats *H. otophila* prevails only slightly (54% *H. otophila* against 46% *H. cretica*).

Haemaphysalids attach themselves primarily to the ears, but they may also be found on the fat tail, udder, abdomen,neck and back. *H. otophila* has a higher preference for the ears, *H. cretica* for the hindquarters. More males than females were found on the hosts. This is again attributed to the longer sojourn of the males on the host.

IXODES

In Israel the genus *Ixodes* is represented on domestic stock by *I. ricinus gibbosus* (Feldman-Muhsam 1955). It is mainly a parasite of sheep and goats but was also found on mule and donkey. It is found only during the winter months (October–February), in the hilly regions of the country, where the maximum daily temperature is about 6°C less than in the coastal plain.

The number of females taken off the hosts was 10–20 times that of males. This surprising sex-ratio in *I. ricinus gibbosus*, is determined by the same factors as in the other genera described above. It is true that the biology of this species has not been studied in Israel, but we assume that it resembles that of *I. ricinus*, because the two species are very similar. Regarding *I. ricinus* Nuttall (1911) mentions Bertkau (1881), who reports that a male fed on his arm for 8 hours whilst the female remained upon him for 8 days. Kossel et al. (1903) like Nuttall, frequently found males running upon the skin of cattle, or in copulation, with females. The assumption that males remain attached to the host only for brief periods, easily explains the observed sex-ratio.

Other species of *Ixodes* found in Israel on rodents, wild mammals, birds or man,

were recorded by Arthur (1958). These are *I. vespertilionis* K., 1844 *I. simplex* Nn. 1906 *I. passericola* Sch., 1933 *I. kaiseri* Arthur, 1957 and *I. redikorzevi theodor* Warburton, 1927.

AMBLYOMMA AND DERMACENTOR

Amblyomma lepidum Dönitz, 1909 was found 3 times during the last 30 years in Israe (Feldman-Muhsam 1955) and can not be considered as a species thriving in thi country. As far as we know, no *Dermacentor* sp. has ever been found in this country

SUMMARY

A survey of Ixodid ticks, carried out in Israel in 1950 showed that domestic stoc is parasitized by the following genera, in order of importance as pests: *Hyalomma* *Rhipicephalus*, *Boophilus*, *Haemaphysalis* and *Ixodes*.

With the exception of *Ixodes* all the genera are found in all parts of the country *Ixodes* occurs mainly in the hilly, colder regions. *Hyalomma* and *Rhipicephalu* thrive mainly during summer; *Boophilus* mainly during winter. *Haemaphysalis* an *Ixodes* are found in the winter only.

Sheep and goats are attacked by all genera and cattle by all except *Ixodes*. *Hyalom ma* and *Boophilus* prefer cattle, while *Haemaphysalis* and *Rhipicephalus* prefer shee and goats.

On cattle *Hyalomma* feeds only on the hindquarters, but in addition to this loca tion *Rhipicephalus* is found on the ears and *Boophilus* on the back. On sheep, *Hyalom ma* feeds only on the tail, whereas *Rhipicephalus* primarily attacks the ears, an *Haemaphysalis* the ears and the hindquarters.

The sex-ratio of ticks collected from their hosts is consistent with observation on the duration of the meal except when the males tend to escape the collector's ey because of their very small size, as for example in *Boophilus*.

REFERENCES

ARTHUR, D.R., 1958, *Ixodes* (Ixodoides, Ixodidae) ticks from Israel, *Bull. Res. Counc. of Israel*, **7E** 206 208.

BERTKAU, Ph., 1881, Bruchstücke aus der Lebens- namentlich Fortpflanzungsgeschichte unser Zecke, *Ixodes ricinus*, Verhandl.d.naturhist.Ver.d. preussischen Rheinlande und Westfalen **38**, Bonn 1881, Sitzungsberichte pp. 145-148.

COSTA, M., 1958, The ectoparasites of mammals and birds in Israel, (*Unpublished thesis, The Hebre University of Jerusalem*).

DIAS, T.S., 1955, Sobre a necessidade do estabelecimento de um novo agrupamento subgeneric para o genero *Hyalomma* Koch 1844, *Ann. Inst. Med. Trop.*, **12**, 499-461.

DAUBNEY, R. AND HUDSON, J.R., 1934, Nairobi sheep disease, Natural and experimental tran mission by ticks other than *R. appendiculatus*, *Parasitology*, **26**, 496.

FELDMAN-MUHSAM, B., 1949, Hibernation of *Hyalomma savignyi* (Ixodidae) in Palestine, *Bull. Entomol. Res.*, **40** (2).

1951, A note on east mediterranean species of the genus *Haemaphysalis*, *Bull. Res. Counc. Israel*, **1** (3), 96–107.

'ELDMAN-MUHSAM, B., 1952, On the identity of *Rhipicephalus sanguineus* Lat., *Bull. Res. Counc. of Israel*, **2** (2), 187–194.

—, 1953*a* On the identity of *Haemaphysalis erinacei*, and *H. taurica*. Ibid.: 2 (4): 372-378.

—, 1953b *Rhipicephalus bursa* in Israel, Ibid. **3** (3), 201 206.

—, 1955 On two rare genera of ticks of domestic stock in Israel, Ibid. 5 **B**(2), 193-194.

'ELDMAN-MUHSAM, B., 1956, Host specifity of *Rhipicephalus sanguineus* (Latreille) and *R. secundus* Feldman-Muhsam in Israel, *Bull. of Entomol. Res.*, **47** (1), 43-45.

—, 1957 Revision of the genus *Hyalomma* II. The subgenus *Hyalommina*, *Parasitology*, **12** (1 and 2), 6 59.

IITCHCOCK, L.F., 1955, Studies on the parasitic stages of the cattle tick *Boophilus microplus* (Canestrini) (Acarina: Ixodidae), *Austral. J. of Zool.*, 3(2), 145-155.

IOOGSTRAAL, H. AND KAISER, M.N., 1959, Observations on Egyptian *Hyalomma* ticks, 5. *Ann. Ent. Soc. Amer.*, 52 (3), 243-261.

IOOGSTRAAL, H. AND KAISER, M.N., 1960, *Boophilus kohlsi* n.sp. (Acarina: Ixodidae) from sheep and goats in Jordan, *J. of Parasitol.*, 46(4), 433-448.

COSSEL, H., SCHUTZ, WEBER, MIESSNER, 1903, Ueber die Hamoglobinurie der Rinder in Deutschland, Arbeiten a.d. Kaiserl. Gesundheitsamte, 20 (1) 77 pp., 3 plates.

IACLEOD, J., 1939, The ticks of domestic animals in Britain, *Empire J. of Exper. Agric.*, 7 (26), 97-110.

IILNE, A., 1947, The ecology of the sheep tick *Ixodes ricinus*, *Parasitol.*, **38**, 27-50.

NUTTALL, G.H.F. et al. 1911, *Ticks*, A monograph of the *Ixodoidea*, Part II. Cambridge, Univ. Press.

PAWLOVSKII, E.N. AND POMERANTZEV, B.I., 1934, Contribution to the question of the distribution of ticks in the zone of pastures on the western slope of Alagez, *Trans. Conn. Study industr. Resources, ser. Transcaucas Leningrad Acad. Sci.*, pt. 11, pp. 49-62.

SERGENT, E., DONATIEN, A., PARROT, L. AND LESTOQUARD, F., 1945, Etudes sur les piroplasmoses bovines, Inst. Pasteur d'Algerie, Alger.

ORGYIA DUBIA TAUSCH. AND ITS PARASITES IN ISRAEL*

J. Kugler

Department of Zoology, Tel Aviv University

Orgyia dubia is very common in Israel. It is not the winged male, however, which is abundant, but the larvae and the cocoons attached to various plants. Despite its abundance, very little has been written about it in Israel. Aharoni (1926) and Bodenheimer (1935) mention it only in passing. A paper on the biology of *Orgyia dubia* was published by Carmin and Scheinkin (1932), in which two parasites are mentioned, *Apanteles* sp. and *Microcryptus* sp. During the last 5 years we have made some observations on the biology of *Orgyia dubia* and our results differ in some respects from those of Carmin and Scheinkin. We also found four additional parasites and three hyperparasites.

The genus *Orgyia* O. belongs to the family Lymantriidae and has an almost worldwide distribution. The males are of normal moth appearance, while in the females there exists a tendency to degeneration of the wings and legs.

In *Orgyia thyellina* Btlr., a Japanese species, the female has well developed wings and is able to fly. In breedings, however, a degeneration of the wings occurs in successive generations but the development of the legs remains normal. In *Orgyia gonostigma* F. and *Orgyia antiqua* L., two European species, the wings of the female are rudimentary, but they are still visible as small outgrowths of the thorax. In these females head and legs are well developed and they are able to leave the cocoon. They move slowly, do not move far and deposit their eggs near the cocoon or on the cocoon itself. In *Orgyia ericae* Germ. and *Orgyia trigotephras* Bsd., also from Europe, the wings are even more strongly reduced, almost invisible, but the legs are still functional. In *Orgyia ochrolimbata* Stgr., a Caucasian species, the legs are very weak and the female is unable to walk. In *Orgyia dubia* Tausch. the wings have disappeared completely and there are only very small rudiments of legs (Figure 3c). The females of the two last mentioned species mate and deposit their eggs inside the cocoons. The young larvae leave the cocoon after devouring the body of their mother. The larva is the only form that is active in dispersion of the species.

The male of *Orgyia dubia* (Figure 1) is of normal appearance. Its wing-span is 20–25 mm. The antennae are bipectinate. The body is hairy. The colour of the forewings is dark brown with yellow spots. The hindwings are dark brown with a yellow triangular field in the middle and with narrow yellow margins.

---

* This paper is part of a doctorate thesis carried out in the Department of Parasitology, The Hebrew University of Jerusalem, under the direction of Prof. O. Theodor.

The distribution of *Orgyia dubia* is as follows: Mediterranean, South-Ukraine, the northern parts of Iran, the area around the Caspian Sea, Altai, Kara-Kum, Siberia (Irkutsk).

Various geographical races of this species have been described; among them *Orgyia dubia judaea* Stgr. from Israel and Egypt.

Carmin and Scheinkin never observed a male entering the cocoon of the female and they therefore concluded that *Orgyia dubia* is parthenogenetic. This is not the case. As already mentioned by Bodenheimer (1935), we often found a male inside the cocoon together with the female. We also reared a great number of females without any contact with males. These females laid eggs, but the eggs never developed.

The fertilised female lays up to 150 eggs. This number is smaller than that of *Orgyia gonostigma* and *Orgyia antiqua* (200–450). The eggs of *Orgyia dubia* are 1mm in diameter, almost spherical, white and glistening. The young larvae hatch 8–12 days after the deposition. The newly hatched larvae is 2 mm long, its head is shiny black, the body is gray with brownish-black hairy warts at the sides. There are two different forms of hairs, thin white hairs and black bristles. On the first and last body segments the hairs are much longer than on the others. Already in the larva of the first instar there are characteristic yellow warts on the back of segments 2,3,8,9 and 10. The thoracic legs are brownish-black, the abdominal legs yellow with black claws. The characteristic yellow osmeteria are clearly visible in the second instar, one on the ninth and the other on the tenth segment. From the third instar on, there appear characteristic brushes of white hairs, emerging from dense short tufts of yellow hairs on the fourth, fifth, sixth and seventh segment (Figure 2).

The larvae of *Orgyia dubia* are polyphagous. In Israel they are found most commonly on *Polygonum equisetiforme*, but also on many other plants, for instance *Alhagi maurorum* and *Statice limonium*.

The full grown larvae usually do not leave the food plant for pupation. They generally spin their white cocoons on the upper branches of the food plant. The cocoon is oval. The length of the female cocoon is 18–21 mm and that of the male 16–18 mm. After completing the cocoon, the larva loses its hairs which stick to the walls of the cocoon and moults. The pupa differs markedly in the two sexes.

The male pupa is typically lepidopterous (Figure 3A), 11–12mm long and dark brown. The female pupa is very different. Carmin and Scheinkin state that there is no pupal instar between the 5th stage larva and the adult female. They mention, however, that Sacharov in Russia, found a pupal instar. In their opinion the plump, hairy egg laying form emerges directly from the larva after moulting in the cocoon. According to our observations, however, a pupal instar exists between the cocoon spinning 5th stage larva and the female. This pupa differs from the female in many respects, although it resembles her in body form. It is nearly hairless, it has a spine (cremaster) at the end of the body and its colour is a shiny yellow-orange immediately after emergence and changes to brownish-black within a day. It differs from a normal lepidopterous pupa by the presence of projecting leg stumps (Figure 3B).

Figure 1. *Orgyia dubia*—male. × 2.

Figure 4. Opened cocoon of *Orgyia dubia* containing cocoons of *Agrothereutes*. × 2.

Figure 2. *Orgyia dubia*—full grown larva. × 1.5.

Figure 5. *Agrothereutes tunetanus*—female. × 4.

Figure 3. *Orgyia dubia*. A–pupa(male), B–pupa

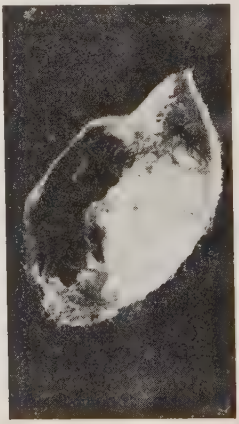


Figure 6. Opened cocoon of *Orgyia dubia* with the

The pupal instar of the female is very short, 3–4 days only. That of the male is 14 ays in summer and up to 40 days in winter. The hatching of the female from the pupa also very peculiar. The female does not emerge, as in other Lepidoptera, through slit on the back but the pupal skin peels off in bits from its body. The colour of ie female is yellowish-orange and she is covered with dense velvety hairs. As ientioned previously, the female does not leave the cocoon and mating and egg ying takes place inside it.

THE PARASITES OF *Orgyia dubia* IN ISRAEL

he larvae of *Orgyia dubia* are very hardy and they apparently do not suffer from iseases and if they are not attacked by parasites, they nearly always reach the adult age. It is easy to rear them in the laboratory, feeding them with leaves of *Polygonum quisetiforme*.

In Israel the larvae of *Orgyia dubia* are attacked heavily by parasites. Up to the resent, six parasites have been found, three Diptera and three Hymenoptera.

Diptera

ll three species of Diptera parasitic in *Orgyia dubia* in Israel belong to the family achinidae: *Exorista segregata* Rond., *Linnaemyia setifrons* Zimin and *Strobliomyia bialis* R.D. They were identified with the help of prof. L.P. Mesnil at the Commonealth Institute of Biological Control, European Laboratory, Delemont, Switzerland.

The first two species have several generations a year and larvae of *Orgyia dubia* arasitised by them are found in all seasons. Larvae parasitised by *Strobliomyia bialis* are found only in winter and early spring (December-April).

xorista segregata Rond.

Exorista segregata is a polyphagous parasite. So far we have reared it in Israel om larvae of the following Lepidoptera: *Orgyia dubia* (Lymantr.), *Lasiocampa 'andis* (Lasicamp.), *Melitea trivia* (Nymphal.), *Acronicta rumicis* (Noct.) and *haumetopoea wilkinsoni* (Thaumetop.).

The female of *Exorista segregata* lays large, white, shiny eggs on the body of the rva. We found up to 6 eggs attached to a single larva. There seems to be no special ace of attachment, it may be on the head, on the body or the legs. Only the last ages of the larvae are attacked.

The maggot of *Exorista segregata* hatches through a slit on the front of the egg etween the convex upper surface and the flat lower surface. It penetrates immediately rough the skin into the body of the host. The posterior end of the maggot remains tached to the hole through which it penetrated, which now serves for respiration. he host creates a funnel around the posterior part of the maggot inside the hole. his funnel becomes black and hard at its basal part. The front part of the maggot tends from the funnel into the body cavity of the host and feeds on the haemolymph id the fat-body. Only towards the end of its development does the maggot attack

the essential organs of the host, and usually leaves the dead host for pupation i the ground. Sometimes the pupation of the maggot takes places inside the cocoo of *Orgyia*, or even inside the body of the dead larva. It may even happen that the infecte larva of *Orgyia* succeeds in pupating, and the parasite pupates within the pupa o the host. The length of the pupal stage of *Exorista segregata* differs during the variou seasons of the year, from 10 days in July to 30 days in January.

In spite of the fact that we found up to 6 eggs of *Exorista segregata* attached t one larva of *Orgyia*, usually only a single maggot completes its development. In few cases we obtained two, and only once three puparia from a single host.

Linnaemyia tibialis Zimin

Linnaemyia setifrons also attacks the larvae of *Orgyia dubia* at all seasons. In spit of the same size and similar colour, it is easy to distinguish between the adult flie of *Exorista segregata* and *Linnaemyia setifrons*: in *Linnaemyia* the palpi are ver small (Figure 7). Similarly the distinction between the maggots and puparia of th two species is not difficult: in *Exorista*, the respiratory slits of the posterior spiracle are nearly straight; in *Linnaemyia* their shape is that of a wavy line. In contrast t *Exorista segregata*, which is oviparous, *Linnaemyia setifrons* is ovo-viviparou After fecundation, its eggs develop inside the vagina. They are banana shaped wit a hexagonal pattern on the chorion. *Orgyia dubia* is the only host of *Linnaemy* *setifrons* known so far.

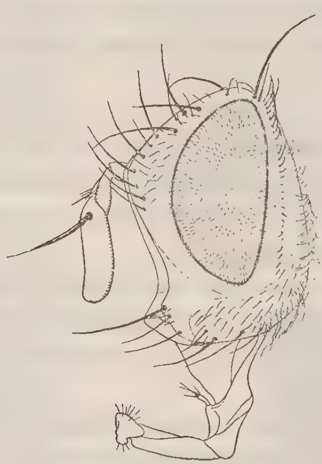


Figure 7. *Linnaemyia setifrons* ♂, head.

Strobiiomyia tibialis R.D.

Strobliomyia tibialis is a small fly, less abundant as a parasite of *Orgyia dubia* than the two other species. We have reared it also from larvae of *Lasiocampa grandis*, always in winter and early spring. It is also ovo-viviparous. Its puparium

easily distinguished from those of *Exorista segregata* and *Linnaemyia setifrons* / its smaller size and by its more projecting posterior spiracles.

We have never found *Strobliomyia tibialis* pupating inside the body of the host or side the cocoon.

Hymenoptera

p to the present, three species of parasitic Hymenoptera are known as parasites *Orgyia dubia* in Israel: the Ichneumonids, *Agrothereutes tunetanus* Haber. and *arylypa humeralis Brauns.*, and the Braconid *Apanteles* sp.

Carmin and Scheinkin mention *Apanteles* sp. and *Microcryptus* sp. as parasites *Orgyia dubia*. According to J.F. Perkins of the British Museum, the specimens etermined as *Microcryptus* are in fact *Agrothereutes tunetanus*.

grothereutes tunetanus Haber.

This is the most important parasite of *Orgyia dubia* in Israel. There are seasons uring which a high percentage of the cocoons of *Orgyia* are parasitised by *Agrotereutes*. Carmin and Scheinkin mention that the females of *Microcryptus* lay their ggs into the body of the *Orgyia* larva. The infected larva spins its cocoon, and

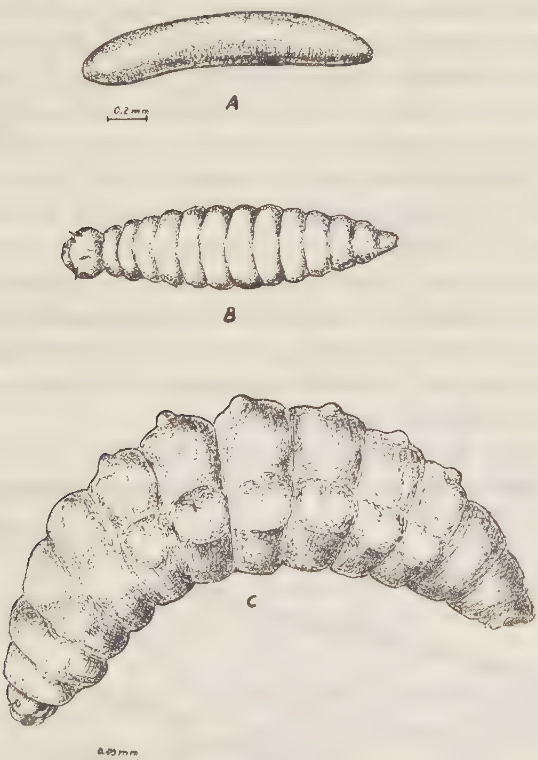


Figure 8. *Agrothereutes tunetanus*. A—egg; B—young larva; C—full grown larva.

before it pupates, the larvae of the parasite leave its body and spin their cocoon inside the host cocoon.

We never obtained *Agrothereutes* from larvae which had been collected in the fielc although cocoons collected in the same places were heavily infected.

In order to clarify this point we placed females of *Agrothereutes* into jars contair ing larvae of *Orgyia*. They did not attack the larvae. However, if we offered ther a cocoon of *Orgyia* with the larva inside preparing for pupation, the female of *Agro thereutes* immediately attacked it. She approached the cocoon, and with tremblin antennae walked over it. She then bent her abdomen to the cocoon and introduced th ovipositor through the wall of the cocoon. The ovipositor could be observed to reac the larva. After a few seconds she extracted the ovipositor, but introduced it agai after a short interval. This was repeated several times, with short intervals. Afte opening the cocoon we found many eggs, all of them on and near the body of th larva, but none inside the body. The same results were obtained repeatedly. Afte examining many cocoons collected in the field we found eggs of *Agrothereute* always on or near the larva, but never inside it.

Although *Agrothereutes* does not lay its eggs into the larva of *Orgyia*, it apparent stings it, as the larva is always paralysed and does not pupate.

The egg of *Agrothereutes tunetanus* is white and banana-shaped (Figure 8 Up to 28 were found in one cocoon of *Orgyia dubia*. The larvae hatch after 3-4 day They do not penetrate into the body of the larva, but attach themselves with the mouthparts to the skin of the host, gnaw a small opening, and feed by sucking th body fluid of the larva. Several times we observed a newly hatched larva attachin itself to an egg of *Agrothereutes*, sucking it empty within 3-4 hours.

The first stage larva of *Agrothereutes* is of a form typical for ectoparasitic Ichneu monids, apodous, with a big head and very small antenae. It is white, transparent, wit only parts of the mouthparts brownish-yellow. The development of the larva is ver short. A larva which hatched on the 28th of February finished its development o the 10th of March and began spinning its cocoon. The full grown larva is very differen from the newly hatched one. The head is relatively much smaller and there are smal projections on the dorsal side of the body.

The fully developed larva spins its cocoon inside the cocoon of *Orgyia dubi* (Figure 4). At first the cocoon is white, but later becomes brownish. The pupal perio

Figure 9. *Agrothereutes tunetanus*, forewing.

lasts 17–20 days in March. The adult wasp emerges through one end of its cocoon and leaves the cocoon of *Orgyia* by making a round opening in its wall.

The two sexes differ chiefly in their colouration. The female (Figure 5), including the ovipositor, is 8–11 mm long, the male 6–8 mm. Head and thorax are black, in the male part of the face, the inner orbitals and the clypeus are white. The antennae of the male are black; those of the female black with a white ring on segments 7–10. The legs are black. The abdomen is red; the last segments and the ovipositor black. The areola of the wing is well developed and pentagonal (Figure 9).

The adults generally copulate soon after hatching. Two to three days after copulation the female begins oviposition.

Barylypa humeralis Brauns.

It is 13 mm long; male and female differ markedly in colour. In the male, frons and vertex are black, the outer orbits reddish-brown, the inner orbits, face and clypeus yellow. The antennae are brown, the thorax mainly black with a yellow scutellum, and reddish-brown sides. The legs are yellow, the abdomen reddish-brown with black posterior segments and black on the upper part of the post-petiolus.

The female is more brightly coloured; the head is entirely reddish brown, the thorax reddish-brown with a yellow scutellum and yellow spots on the sides. The abdomen is reddish brown with a narrow black stripe along the post–petiolus.

The antennae are not very long, slightly longer than half the length of the body. The wing is without an areola (Figure 10). The ovipositor projects only very little from the abdomen.

Figure 10. *Barylypa humeralis*, forewing.

Barylypa humeralis is an endoparasite. The only three specimens we obtained hatched from male pupae of *Orgyia dubia* collected in Kfar-Yeruham on the 24.IV. 59; two males hatched on the 18.X.59 and a female on 24.X.59. Another specimen of *Barylypa* hatched from a male pupa of *Amicta quadrangularis nigrescens* (Psychidae) which was also collected in Kfar-Yeruham on 24.IX.59.

Apanteles sp.

This is an endoparasite of the larvae of *Orgyia dubia.* No external signs of infestation with the parasite are visible on the infested larva. The parasitic larvae possess the respiratory vesicle on the end of the abdomen which is characteristic of species of

Apanteles and some other parasitic Hymenoptera. This vesicle is a prolapse of th hind gut and serves as a blood gill, absorbing oxygen from the haemolymph of th host. The hind chamber of the heart of the *Apanteles* larva projects into the vesicle.

The greatest number of *Apanteles* larvae found in one larva of *Orgyia dubia* wa 40. The fully grown larvae of *Apanteles* leave the host only after it spins its cocoon Immediately after leaving the host they begin to spin their own cocoons inside th cocoon of the host. First they excrete a tangled mass of white threads and afterwar each larva spins its own cocoon inside this coil of threads (Figure 6).

THE HYPERPARASITES

Three species of hyperparasites were found in *Orgyia dubia*. Two species were iden tified by G.J. Kerrich of the British Museum as *Pediobius* sp. and *Tetrastichus* sp (Eulophidae) and the third species by Z. Boucek, Prague as *Brachymeria kassalensi* Kirby (Chalcididae).

The Chalcidoidea, parasitic in Tachinidae, usually attack the larva (or puparium after its exit from the host. The three species mentioned, however, attack their host inside the larva of *Orgyia*. We obtained them repeatedly from larvae of *Orgyi* collected in the field.

Brachymeria kassalensis was found only once. A cocoon of *Orgyia dubia* wa collected at Kfar-Yeruham on 23.V.58. Inside the cocoon was a larva of *Orgyia* with a puparium of *Exorista segregata* inside its body. On 11.VI.59, a specimen o *Brachymeria kassalensis* hatched from this puparium.

Brachymeria kassalensis is 7 mm long. It is black with white tegulae and red white and black hind legs. Outside Israel it is known from Egypt and Ethiopia.

Pediobius sp. and *Tetrastichus* sp. are very small, 1.5–2.5 mm. Up to 50 specimens were obtained from a single puparium of *Exorista segregata* or *Linnaemyia setifrons*. They also hatched from the cocoons of *Apanteles* inside the cocoon of *Orgyia*. Not all larvae of *Apanteles* were infested however, and we obtained from the same mass of *Apanteles* cocoons, adults of both the host and the parasite species.

PERCENTAGE OF PARASITISM

As shown in Table I, of 699 cocoons examined, 413 were found to be infested. Some of them by *Agrothereutes*, some by Tachinidae, some by *Apanteles* and some by two parasites. In case of double infestation the cocoon was counted twice, once as being infested by Tachinidae, and once as being infested by *Agrothereutes* or *Apanteles*. Thus, in the table, the sum of the number of cocoons infested by *Agrothereutes*, *Apanteles* and Tachinidae is greater than the total of the parasitised cocoons.

The most important parasite of *Orgyia dubia* in Israel is *Agrothereutes tunetanus*; 32.4% of the cocoons were infested with this parasite. 19.7% were infested by Tachinidae. The Tachinidae were found either as larvae inside the host, or as puparia inside the cocoon together with the dead host. The number of cocoons infested by Tachinidae is larger than indicated in the table, because many of the cocoons con-

aining dead larvae of *Orgyia* had probably been infested by Tachinidae, but the naggots had left the cocoons for pupation in the ground. If the number of these ocoons is added to those containing larvae or puparia of Tachinidae, the percentage f cocoons infested by Tachinidae rises to nearly 40%.

Although the number of cocoons examined is not very large, it shows that the nfestation with parasites varies during the different seasons. In winter and spring

TABLE I

Parasites in cocoons of Orgyia dudia

Date	Place	Number of cocoons examined	Number of cocoons parasitised	Ag.	Ap.	T.	Dead. L.	T+Ag	T+Ap
1.I.57	Hadar Joseph[1]	17	13	7	3	4			1
1.I.58	Petah-Tikva	23	18	13		6	3	4	
8.I.56	Petah-Tikva	15	12	11		3		2	
10.I.56	Petah-Tikva	40	33	22		1	10		
14.I.58	Hadar-Joseph	10	10	8		4	1	3	
21.I.56	Petah-Tikva	4	3	3		2		2	
21.I·58	Tel-Aviv	25	19	10	1	2	7	1	
22.I.58	Pàash[2]	14	12	12		2		2	
18.II.56	Getah-Tikva	3	1		1				
22.II.56	Gàash	13	12	8	1	1	2		
1.III.56	Gàash	18	17	16			1		
6.III.56	Kfar-Yeruham[3]	16	14	5		8	1		
28.III.57	Kfar-Yeruham	105	78	33		52	5	12	
2.IV.56	Tel-Izhak[4]	22	20	18		2			
12.IV.56	Kfar-Yeruham	25	25	11		8	8	2	
29.IV.56	Tel-Izhak	17	12	7	2	5		2	
9.V.56	Tel-Izhak	14	11	6		4	1		
23.V.56	Kfar-Yeruham	48	46	20		8	18		
.VIII.59	Petah-Tikva	18	3	1			2		
24.IX.56	Kfar-Yeruham	37	18	1		12	5		
27.IX.59	Tel-Izhak	104	3			1	2		
28.IX.60	Tel-Aviv	5	1		1				
28.IX.60	Ramat-Gan[5]	75	12	3		7	2		
8.X.60	Petah-Tikva	7	3	1		2			
2.XI.56	Betah-Tıkva	13	10	7		1	2		
.XII.56	Petah-Tikva	11	7	4		3			
	Total	699	413	227	9	138	70	30	1
	Percentage %		59	32.4	1.2	19.7	10		

g. = *Agrothereutes tunetanus*; Ap. = *Apanteles* sp.; T = Tachinidae; Dead L. = Dead larva of *rgyia* (the parasite left the cocoon); T+Ag = Tachinidae + *Agrothereutes*; T+Ap = Tachidae + *Apanteles*.

near Tel-Aviv; 2. near Natanya; 3. 30 km south-east of Beersheba; 4. near Natanya; near Tel-Aviv.

the percentage of cocoons containing parasites is very high, in some cases 100% In August and September the percentage of parasitised cocoons is very low. Thi is particularly marked in the case of *Agrothereutes tunetanus*. The rarity of *Orgyi* in summer is probably caused by the great number of parasites in spring, and th scarcity of parasites in August and September may be the cause for the great increas of the population of *Orgyia* in winter.

REFERENCES

1. Aharoni, J., 1926, Monographs on the biology of insects: *Orgyia dubia*, *Hassadeh*, 6 70, (in Hebrew).
2. Bodenheimer, F.S., 1935, *Animal Life in Palestine*, Jeruaslem, 218.
3. Carmin J. and Scheinkin, D., 1932, The Fauna of Palestinian Plants, *Bull. de la Soc. Roy. d'Egypte*, 204-215.
4. Clausen, C. P., 1940, *Entomophagous Insects*, New York.
5. Herting, B., 1960, Biologie der Westpalaearktischen Raupenfliegen Dipt., Tachinidae, *Monogr zur Angew. Entom.*, **16**.
6. Kojanzikoff, I.V., 1950, *Fauna SSSR*, Volneankji (Orgyidae), **12**, Akad, Nauk. SSSR, Moskva
7. Mesnil, L.P., 1944–1960 Larvaevorinae (Tachininae), In Lindner, E., *Die Fliegen der Palae-arktischen Region*, **64**, g, Stuttgart.
8. Seitz, A., 1913, *Die Grossschmetterlinge der Erde*, Stuttgart.
9. Zimin, L.S., 1954, Wide roda Linnaemyia R.D., *Fauna SSSR*, Trudy zool. Inst. Akad., Nauk SSSR, **15**, 228.

THE FIRST INVESTIGATIONS ON HARMFUL THYSANOPTERA OF TURKEY

BEKIR ALKAN
Institute for Plant Protection, The Agricultural Faculty, University of Ankara

INTRODUCTION

The Thysanoptera are represented by many species which are widespread every-vhere in Turkey. *Thrips tabaci* (Lind) is one of the most common and detrimental pecies; its biology, ecology and control have been studied by M. Ileri (1948), M. S. Karman and O. Celebi (1960) in Western Anatolia. Other thysanopterous pecies are little known in Turkey. So far, most of them have neither been investigated ıor classified. I have been working for many years on the distribution of thysa-ıopterous species and the classification of their host plants. Recently, several new pecies have been collected and were identified by the British Museum (Natural History) of London. No compilation of the Turkish Thysanoptera and of their host plants has been published so far. Therefore I have attempted this undertaking and ıave listed for the first time all known species including their hosts. The following rticle is not claimed to be a comprehensive catalogue of Turkish Thysanoptera; the reatest part of the work still remains to be done.

THE KNOWN SPECIES AND THEIR RESPECTIVE HOST PLANTS

Family: THRIPIDAE

1. *Thrips tabaci* (Lind). Its main area of distribution is western and north-western Turkey. The pest is controlled year by year by means of insecticidal sprayings. It ttacks *Nicotiana tabacum*, including its various varieties and hybrids. Both imagoes nd larvae suck tobacco leaves, causing the appearance of white spots along the leaf eins (called "Akdamar" in Turkish). Several colour aberrations of *Thrips tabaci* (Lind) were observed: The yellow one invariably attacks tobacco plants. In "most avourable" years it produces annually 9–10 generations in Western Anatolia from April to October. Both larvae and adults hibernate in the soil or in plant residues.

T. tabaci (Lind) is extremely polyphagous; apart from on tobacco it was observed o feed on the following plants: Cotton, grapes, wheat, maize, sugar beet, potato, lossoms of apple, pear and on other trees, sunflower, onion, lactuca, porree egg-lant, paprika, spinach, edible beans, horsebeans, peas, *Vicia*, *Trifolium*, Schnittlauch, abbage, cauliflower, watermelon, surgarmelon, sesam, poppy, *Medicago sativa*, urbit, cucumber, mustard, *Malva*, *Convolvulus*, *Daucus carata*, *Vitex*, *Senecio*,

Muscari, Lamium, Lathyrus, Chenopodium, carnation and other flowers, variou ornamental plants and on weeds.

2. *Thrips angustipes* (Uzel). According to Ileri (1948) this species attacks vege tables, field plants, mustard, and herbs in western Turkey. The author does no name the species of the host plants.

3. *Taeniothrips inconsequens* (Uzel). Syn: *Euthrips pyri* (Daniel), *Physothrip inconsequens* (Karney), *Taeniothrips pyri* (Fort et Jones), *Physopus inconsequen* (Uzel) etc., have been found to feed on blossoms, buds and fruit of pear trees ir Ankara (Düzgünes 1955). Other host plants have not yet been observed in Turkey.

4. *Taeniothrips simplex* (Moris). Syn: *T. gladioli* (Moult et Stnw.) attacks the leaves of gladiolus and carnation in Istanbul (Düzgünes 1952).

5. *Heliothrips haemorrhoidalis* (Bouché) (Greenhouse Thrips). This polyphagou species is particularly widespread in southern and western Turkey. It is found in the field as well as in greenhouses where it was observed together with *Heliothrips femo ralis* (Reut), and *Thrips tabaci* (Lind), on ornamental plants (Bodenheimer 1958 the names of which are not given by the author. In the field, *Heliothrips haemorrho dalis* sucks the leaves and fruits of citrus trees in southern and western Turkey (Boden heimer 1958, B. Alkan 1953). S. Özek reported that this insect is found also on frui trees, the names of which he does not mention. *H. haemorrhoidalis* (Bouché) was ob served particularly on leaves of cotton, edible beans and cucumber; as well a on leaves, buds and blossoms of grapes in western Turkey (Iyriboz 1938, 1941) This insect causes spots on the leaf surface sucking upon grapes and cottor leaves. During dry years the damage is rather extensive.

6. *Hercinothrips* (*Heliothrips*) *femoralis* (Reut). Iyriboz (1938 and 1941) reportec that this insect attacks the leaves of grapes, cotton, cucumber, and edible bean in eastern Turkey, whereas Bodenheimer (1958) describes it as a pest of ornamenta plants in greenhouses.

7. *Hercothrips* (*Heliothrips*) *fasciatus* (Perg). This species is particularly wides pread in western Turkey. According to Iyriboz (1938 and 1941) it sucks the leave of cotton, edible beans, *Medicago sativa* and grapes, but causes only mino damage. The identification of this insect was carried out by the British Museum of London.

8. *Limothrips cerealium* (Halid). The larvae and imagoes attack grain and mea dow-grasses occasionally (Bodenheimer 1958, B. Alkan 1942). 2–3 generation were observed annually.

9. *Thrips flavus* (Schr.) This species was found to suck the leaves of cotton edible beans and cucumber in western Turkey (Iyriboz 1941), causing only smal damage.

10. *Scolothrips longicornis* (Priesn.) attacks according to N. Iyriboz (1941), cotton leaves in western Turkey.

11. *Odontothrips confusus* (Priesn.) was observed by Mehmet Duran in 1958 on the blossoms of *Medicago sativa* in middle Anatolia and was classified by the British Museum (Natural History), London. H. Oettingen (1952) claimed *O. confusus* Pr. to be a regular inhabitant of alfalfa fields in Asia Minor and to be found also in Europe.

Family: PHLOETHRIPIDAE

12. *Liothrips oleae* (Costa) Syn: *Phloeothrips oleae* Uzel., *Cryptothirps novaky* Karny, *Liothrips novaky* (Priesn.), *Thrips oleae* (Costa). This species is common in all olive areas where it feeds on blossoms, buds, leaves and young fruit of olive trees (Iyriboz 1941). There are annually 3–4 generations.

13. *Liothrips setinodis* (Reut.) is found, according to Schimitschek (1944), on the lower surface of oak leaves (*Quercus conferta*) in the Belgrader forest near Istanbul.

14. *Haplothrips tritici* (Kurdj.) This insect is abundant everywhere and attacks grain, particularly wheat (Iyriboz 1941; B. Alkan 1942, 1948; Bodenheimer 1958).

15. *Haplothrips aculeatus* (Fabr.) Syn: *Anthothrips aculeatus* (Fabr.), *Phloeothrips frumentaria* (Beling) lives in grain and meadow-grasses (Iyriyoz 1941, Bodenheimer 1958 B. Alkan 1948).

16. *Haplothrips distinquendus* (Uzel) was found by Bodenheimer (1948) on *Triticum*, *Eremurus* and *Stipa*.

17. *Haplothrips niger* (*Osborn*) Syn: *Anthothrips niger* Osborn., *Haplothrips trifolii* (Osborn.), *Haplothrips stacices* (Auct.)

This pest was found for the first time by Mehmet Duran in 1958 near Konja in Turkey, destroying blossoms of *Medicago sativa*. It was classified by the British Museum (Natural History), London.

Family: AEOLOTHRIPIDAE

18. *Aeolothrips intermedius* (L) Bagn. was first observed by Mehmet Duran in 1958 on blossoms of *Medicago sativa* near Konja, its identification was carried out by the British Museum of London.

I presume that the following species certainly occur in Turkey: *Limothrips denticornis* (L.), *Frankliniella tenuicornis* (Uzel), *F. intonsa* (Tryb.), *Stenothrips graminum* (Uzel), *Anaphothrips obscurus* (Müll.), *Chirothrips* spp.

REFERENCES

1. ALKAN, B., 1942, Ekin Thrips böceği, Ziraat dergisi, yil 3, sayi 30, Ankara
2. ALKAN, B., 1946, Tarim Entomolojisi, Ankara.
3. ALKAN B., 1948, Orta Anadolu hububa zararlilari, Ankara.

4. Alkan, B., 1953 Türkiyede Narenciye hastalik ve zararlilari, Ankara.
5. Balachowsky, A. et meshil, L. 1936, Les insectes Nuisibles aux Plantes cultivées, Paris.
6. Blunck, H. und Sorauer, P., 1049, *Handbuch der Pflanzenkrankheitein, Vierter Band*, erster teil, erste Lieferung, Berlin.
7. Bodenheimer, F. S. 1951, *Citrus Entomology in the Middle East*, S–Gravenhage
8. Bodenheimer, F.S., 1958, Türkiyede Ziraata ve agaslara zararli olan Böcekler ve bunlarla savaş hakkinda bir etüd, Ankara.
9. Düzgünes, Z., 1952, *Taeniothrips simplex* Morison (*Gladiolus thripsi*) Bitki Koruma Bülteni sayi 3, 27–30 Ankara.
10. Düzgünes, Z., 1955, *Armut thripsi* (*Taeniothripsi inconsequeus* Uzel) Tomurcuk Dergisi yil 4, cilt 4, sayi 38, S.,6-9, Istanbul.
11. Ileri, Mesude, 1948, Tütünlerde Akdamar ve önlenme çareleri üzerinde araştirmalar, Ankara.
12. Iyriboz, N., 1938, Bag hastaliklari, Ankara.
13. Iyriboz, N., 1941, Zeytin hastaliklari, Izmir.
14. Iyriboz, N., 1941, Hububat hastaliklari, Izmir.
15. Iyriboz, N., 1941, Pamuk hastaliklari, Izmir.
16. Karman M.Ş. ve Çelebi, O., 1960, Tütün zararlirari, Izmir.
17. Metcalf, C.L., Flint, W.P. and Metcalf, R.L., 1951, *Destructive and Useful Insects*.
18. Nizamlioglu, K., 1957, Türkiyede Meyva agaçlari zararlilari ve mücadelesi, Istanbul.
19. Oettingen, H., 1952, Blasenfüsse, Die neue Brehm-Bücheri, Leipzig.
20. Pape, H., 1955, Krankheiten und Schädlinge der Zierpflanzen.
21. Schimitscheck, E., 1944, Forstinsekten der Türkei und ihre umwelt.
22. Tütün ürünü Akdamardan nasil korunur. Inhisarlar tütün Enstitütüsü yayinlarindan B. Seris Nr: 16 yil 1945, Istanbul.
23. Ziraat Vekâleti V. inci ve VIII. inci Ziraî Mücadele Kongresi Kararlari 1956 ve 1958 Ankara.

BIONOMICS OF THE JASMINE MOTH (*GLYPHODES UNIONALIS* HUEBNER) IN THE COASTAL PLAIN OF ISRAEL

Z. AVIDOV AND D. ROSEN

The Hebrew University Faculty of Agriculture, Rehovoth

ABSTRACT

The Jasmine Moth (*Glyphodes unionalis* Huebner) is a serious pest of the olive, the jasmine and the ligustrum in Israel. During the years 1957–1959 the bionomics and phenology of the pest were studied by means of rearings, laboratory experiments and observations in olive groves.

The duration of development of the egg is from 3 days to approximately 3 weeks, that of the larva from 2 weeks to 3 months, and that of the pupa from a week to 2 months, all these durations depending on the temperature.

The mortality among the eggs in the rearings is low in all the generations: 16% or less. The mortality among the larvae is greater: 40–50% in generations living under extreme climatic conditions (heat or cold) and less than 30% in the other generations. Moths succeeded in emerging from most of the pupae (usually more than 90%).

Experiments proved that extended "Khamsin" conditions have a fatal effect on the eggs and pupae.

The adults live an average of one week during the summer, and about 2 months during the winter. The number of eggs laid by a fertilized female was 590 on the average, and a maximum of more than 1200 eggs were laid by one female.

In the coastal plain of Israel the pest develops 6 generations annually, most of which overlap each other.

Experiments on rearing the larvae on various plants of the Oleaceae family showed that the duration of larval development and the degree of mortality on the various hosts are different under similar climatic conditions, though most of the plants examined served as satisfactory hosts for the larvae.

Two species of Braconids and one Tachinid were found as parasites of the Jasmine Moth larvae. The larvae of a Chrysopid are capable of devouring the Jasmine Moth larvae; but all of these beneficial insects have apparently no significance in the control of the pest populations.

INTRODUCTION

he Jasmine Moth is very widespread in the tropical and mildly subtropical regions ' the old world. It is one of the known olive pests of the Mediterranean countries ıd is known as a serious pest of jasmine in France and Java.

In Israel the Jasmine Moth has been recognized for many years as a pest of the ive, jasmine and ligustrum (Avidov 1949, Bodenheimer 1930). During the last few ars the damage caused by this pest in olive groves has increased in the various gions of the country, especially in the Northern Negev. Since information on its e history in Israel was lacking, it was necessary to study the bionomics of the smine Moth in the coastal plain of Israel.

Details of this research are based on laboratory work in Rehovoth. Continuou rearings of all stages of the pest were carried out in 1957–1959 and various ecologica experiments were conducted. A monthly survey was also conducted on the appearanc and damage of this pest in four olive groves in the Northern Negev.

THE EGG

Duration of development of the egg

Fertilized females were held in paper-lined half-liter jars. The papers, on which egg were laid during the night, were collected every morning in similar cheese-clotl covered jars which were put in a roofed screenhouse (to prevent the influence o direct radiation and rain). The eggs were examined daily and the average temperatur during the development of each egg was calculated.

In this way data on duration of development of 7306 eggs were collected. Al these data were used for the calculation of the equilateral hyperbola equation (Boden heimer 1930) in the following way: data on duration of development were converte to their reciprocals and then the regression line was calculated by the least squar method. The parameters of the hyperbola were obtained from the straight lin equation.

TABLE I
Duration of development of the egg (days)

°C	No. eggs	Minimum	Maximum	Average
10	11	33	36	34.7
14–15	604	11	17	13.9
16–17	74	9	13	9.8
19–20	547	5	8	6.8
21–22	1091	4	6	5.4
23–24	1041	3	5	4.8
25–26	1883	3	5	3.7
27–28	2055	3	3	3.0

Table I summarizes the data on duration of development of the egg. Figure 1 illustrates the hyperbola calculated on the basis of these data. The equation of the regression line is: $Y' = -0.14381 + 0.01636\ X$, and the parameters of the hyperbola are as follows: the theoretical threshold of development $c = 8.8°C$, and the thermal constant Th.C = 61.1 days-degrees.

The development of the eggs of the Jasmine Moth is possible in the coastal plain during every month of the year. In the hot season the development is very rapid and takes only 3–4 days. In the cold season the development usually takes 2–3 weeks.

Experiments were also conducted on the influence of constant temperature and humidity conditions on the duration of the development of the egg, and it was found

hat all the eggs died at 37°C independent of different humidity conditions. 'he durations of development of the eggs that remained alive in the other combina-ions (12°–30° C and RH 11–90%) were not at all influenced by the humidity in the ir but only by the temperature.

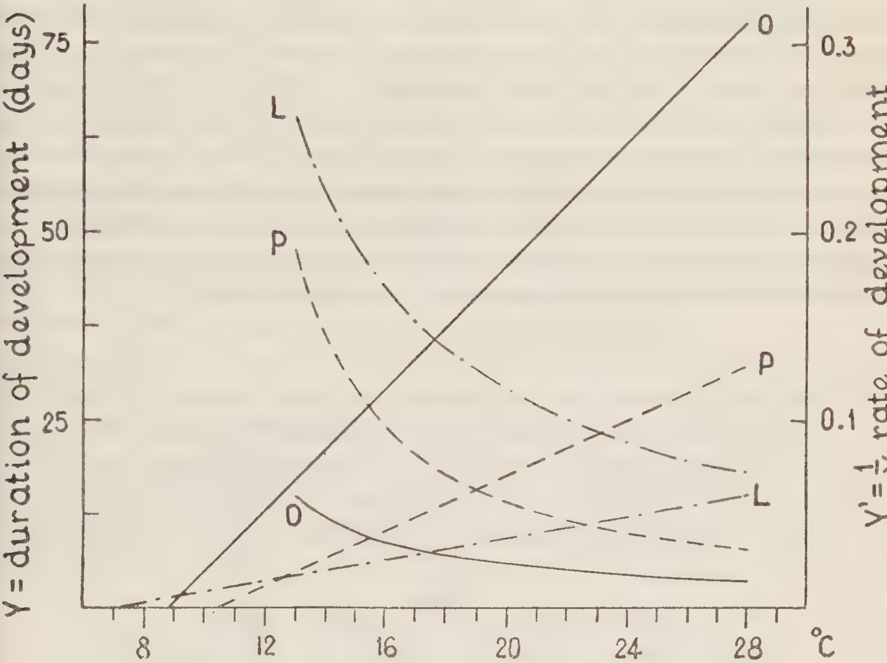


Figure 1.
Duration of development of Jasmine Moth eggs, larvae, pupae.
The straight lines indicate the rate of development.

Natural mortality among the eggs

'able II summarizes the data on the mortality among the eggs of the laboratory earing according to the months in which they were laid. The lowest mortality of ggs occurred in the spring and at the beginning of the summer. The mortality ose slightly in the hot month of August and reached its peak in autumn and winter.

TABLE II
Mortality among eggs reared in the laboratory

Month	°C	No.eggs	%Mortality
IV	18–19	372	5.9
V	19–20	331	10.3
VI	21–26	2418	13.1
VII	25–28	2410	8.2
VIII	27–28	5168	16.0
IX	25–27	2379	15.6
X	21–23	845	25.8
XII	14–17	1281	26.8

Experiments on the influence of duration of "Khamsin" conditions on mortality of egg*

Papers on which eggs were laid during the night were, in the morning, put unde constant conditions of 36°C and 30% relative humidity, which are conditions simila to those of a "Khamsin" and were left three for several hours. At the end of the se time the eggs were taken out of the Khamsin conditions and transferred to cheese-clot covered jars that were put into the screenhouse. After hatching, the number of egg that died was noted. From the results, summarized in Table III, it can be conclude that a Khamsin that lasts up to 12 hours does not cause increased mortality of eggs Every increase in the duration of the Khamsin beyond 12 hours results in a larg increase in the mortality. It should be noted, however, that in Israel the occurrenc of a heavy Khamsin that continues for more than 18 *consecutive* hours is rare Khamsins that last several days with a slight relaxation at night, are quite frequen and they may have a fatal influence on the Jasmine Moth eggs.

TABLE III

Influence of duration of "Khamsin" (Temp. 36°C, 30% RH) on egg mortality

Duration (hours)	No. eggs	% Mortality
6	75	4.0
12	54	0.0
18	100	9.0
24	97	33.3
48	113	90.3

THE LARVA

Duration of larval development on young olive foliage

Young larvae were transferred, on the day of their hatching, to tender, young oliv branches kept in water. The bottles with the branches and larvae were put int 4–6 liter jars which were covered with cheese-cloth and were put into the screenhouse The food was changed as necessary and the larvae were kept in the jars until the pupated. Observations and counts were made daily and the average temperatur during the development of each larva was calculated.

Figure 1 illustrates the hyperbola calculated on the basis of the data presente in Table IV. The regression line equation is : $Y' = -0.20703 + 0.002770\ X$, and th parameters of the hyperbola are as follows : $c = 7.5°C$; Th.C = 361 days-degrees Considerable variations in the duration of larval development at the same temperatur were observed (see Table IV).

* A hot, dry desert wind.

TABLE IV
Duration of larval development on olive (days)

°C	No. larvae	Minimum	Maximum	Average
13–14	55	68	111	88.6
18–19	21	32	44	36.3
20–21	70	19	36	23.6
22–24	68	17	25	19.4
26–28	247	14	25	18.8

A comparison of Table IV and Figure 1 reveals that there are wide discrepancies etween the data on duration of development that were obtained from the rearings nd the corresponding values calculated according to the hyperbola. These iscrepancies testify to the existence of additional factors, besides temperature, that reatly influenced larval development. Such a factor was, apparently, food quality. t was not always possible to find fresh growth on olive trees).

Development of the Jasmine Moth larva is possible in the coastal plain during very month of the year. During the hot season larval development takes 2–3 ½ eeks and during the cold season it may take as much as 3 months and more.

Special experiments were conducted to examine the development of the larvae on ther parts of the olive tree and they proved that the larvae cannot develop on olive aves older than a year. The larvae develop properly on olive inflorescenses and on uit of every size.

TABLE V
Mortality among larvae reared on young olive leaves

Month	°C	No. larvae	% Mortality
XII-III	13–13.5	111	53.1
IV-V	20–23	99	27.3
VI	24–25	49	28.5
VII	27	59	22.0
VIII	27–28	175	46.2
IX	24–27	148	29.0
X-XI	18–21	60	43.3

Natural mortality of larvae on young olive foliage

able V summarizes the data on the natural mortality among the larvae reared on oung olive foliage, according to the months in which they developed. Mortality f larvae was greater than that of eggs. The greatest mortality occurred during the rst week of larval development, and a considerable percentage died during pupation. he lowest mortality occurred in the spring and at the beginning of the summer; the hot month of August the mortality increased greatly; the mortality reached s peak in the winter months.

Observations on the behaviour of the larvae

The larva begins to move immediately after hatching and quickly departs from the egg shell. In its search for food the young larva is capable of travelling a considerable distance and it is attracted to olive branches that are found in the vicinity.

The larvae are active at night. During the day they do not feed but lie motionless in a shady place. The young Jasmine Moth larvae reveal negative phototropism.

Before pupating the larva finds itself a hiding place among the leaves, in the cracks of the bark, etc. It spins a bed of loosely woven threads with a slightly denser cocoon inside, it contracts, remains motionless for several hours to a day or two, and pupates.

THE PUPA

Duration of pupal development

Immediately after pupating, the pupae were transferred to half-liter cheese-cloth covered jars that were put into the screenhouse. Observations and counts were made daily and the average temperature during the development of each pupa was calculated.

No difference in the duration of development resulted from the different food plants on which the larvae were reared. Therefore the equilateral hyperbola equation was calculated on the basis of all the data (748 pupae), by the same method used for the development of the eggs.

TABLE VI
Duration of development of the pupa (days)

°C	No. pupae	Minimum	Maximum	Average
15–16	69	21	32	25.6
17–18	28	15	22	18.8
19–20	15	14	17	15.9
22–23	143	9	13	10.6
24–25	77	8	12	9.9
26–28	416	6	10	8.1

Table VI summarizes the data on duration of pupal development. Figure 1 illustrates the hyperbola calculated on the basis of these data. The regression line equation is: $Y' = -0.075114 + 0.007360\ X$, and the parameters of the hyperbola are as follows: $c = 10.2°C$; Th. $C = 135.9$ days-degrees.

The development of the Jasmine Moth pupa is possible in the coastal plain during every month of the year. During the hot season the development takes a week or more and during the cold season it may take up to two months.

Natural mortality among pupae

able VII summarizes the data on the mortality among the reared pupae according the months in which they pupated. Mortality of pupae was lower than that of gs and larvae. The lowest mortality occurred at the beginning and at the end of e summer. It rose in the hot month of August and reached its peak in the winter onths.

TABLE VII

Mortality among reared pupae

Month	°C	No. pupae	% Mortality
III–IV	16–20	48	12.5
V	22–24	129	12.4
VI	24–27	63	7.9
VII	26–28	231	8.6
VIII	27–28	139	12.2
IX	25–26.5	126	5.5
X	22.5–23	78	5.1
XI-XII	15–18	101	29.7

xperiments on the effect of duration of Khamsim conditions on mortality of pupae

ewly-formed pupae were put under constant Khamsin conditions (36°C, 30% lative humidity) and were left there for several days. At the end of the fixed period time the pupae were removed from the Khamsin conditions and were transferred jars covered with cheese-cloth that were put into the screenhouse. The number moths that emerged and their condition, were examined daily. It was found that ter one day of Khamsin conditions, 72.7% of the pupae succeeded in developing to normal moths; after two days of Khamsin conditions only 45.4% of them veloped into normal moths; after three days of Khamsin — 30.7%; after four ys of Khamsin no normal moths emerged from the pupae.

THE ADULTS

t first the adults were kept in half-liter glass jars with perforated metal covers. male and a female were put into each jar. By this method mating occurred only rely and the moths died after a short time. Therefore the following method was lopted: the female was transferred, immediately after its emergence, to a 4–6 liter r in which several males were kept, and was left there for 24 hours. From there it as transferred to a half-liter paper-lined jar with a perforated metal cover.

The adults were fed sugar- or honey-water solution. The jars, which were put to the screenhouse, were examined daily. The average temperature during the e of each adult was calculated.

The moths are active principally at night and only then do they mate and lay eggs. t night they are attracted to light. The male is capable of mating several times. ne mating is sufficient for the female. The females of the laboratory rearings mated ostly on the second night of their lives, but even 5–7 days old females were capable mating. The males mated at the age of 1–7 days.

TABLE VIII

Life span of the adults

°C	Males				Fertilized females				Unfertilized females			
	No.	Minimum	Maximum	Average	No.	Minimum	Maximum	Average	No.	Minimum	Maximum	Average
12–13	6	42	84	62.1					2	45	47	46.0
14–16	14	20	48	37.7	19	14	37	25.2	6	19	43	30.1
19–23	53	6	44	16.8	23	12	28	17.8	24	10	35	23.0
24–25	55	3	29	15.3	36	5	29	12.4	13	4	29	17.0
26–28	48	2	15	8.0	31	4	15	8.1	18	3	14	8.7

TABLE XI

Larval mortality and duration of development on various host plants

Host Plant	*Phyllyrea* media	*Fraxinus syriaca*	*Jasmimum officinale* var. *grandiflorum*	*Jasmimum sambac* old leaves	*Jasminum sambac* young leaves	*Jasminum azoricum*	*Ligustrum sinense*	*Ligustrum lucidum*	*Ligustrum japonicum*
Average temperature (°C)	21	24	24.5	24	24	24.5	23	23	24
No. of larvae	27	25	20	25	25	20	25	24	30
Mortality (%)	22.2	22.2	4.0	40.0	80.0	70.0	40.0	20.8	10.0
Average duration of development (days)	18.4	14.7	24.5	19.2	27.4	23.7	23.5	17.8	15.2

Life span of the adults

Table VIII summarizes the data on the life span of the adults. This shows that the life span of fertilized females is generally shorter than that of the males. The life span of the non-fertilized females was always greater than that of the fertilized ones. The adults live, on the average, more than a week during the hottest season and up to two months in the cold season.

Fertilized females

The preoviposition period of the fertilized female lasted: 2–3 days from May to November; 3–8 days (5 on the average) from December to April. Oviposition period lasted 2–11 days in the summer and 9–30 days in the winter. Senescence lasted up to 9 days. In every generation there were females who died several hours after laying their last eggs.

Table IX summarizes the number of eggs laid by the fertilized females in our rearings. The highest oviposition occurred at the beginning of the summer. In the middle of the summer, and to some extent in the winter too, there was a decrease in the number of eggs laid. That there is no correspondence between the duration of the oviposition period and the number of eggs laid.

TABLE IX

Number of eggs laid by fertilized females

Month	No. females	Minimum	Maximum	Average
IV-V	4	458	882	670.2
VI	18	426	1211	812.4
VII	9	263	792	496.8
VIII	22	83	718	435.6
IX	18	258	880	547.9
X-XI	19	427	851	622.7
XII-I	18	320	735	522.7
Total	108	83	1211	591.2

The oviposition was continuous, daily. Only during the winter were there short interruptions in egg-laying, mostly on cold nights, when the average daily temperature fell below 10.5°C. This seems to indicate that the oviposition threshold is higher than the threshold of development of the egg.

In the rearings, eggs were laid on all parts of the jar, chiefly on the paper lining the sides and on the perforated metal cover. They were laid singly or in dense groups that contained up to 95 eggs, at times in two layers. In the grove, eggs were found that had been laid singly on both sides of the olive leaves.

Number of ripe eggs in the female's abdomen

On dissecting female pupae on the last day of their development, no ripe eggs that had reached full size were found in their ovaries. Only un-ripe ovules were found. On dissecting virgin females on the day of their emergence, 15–95 (63 on the average) ripe eggs were found in their ovaries. If we keep in mind the large number of eggs laid on the first day of oviposition, we can understand that their final ripening occurs only after emergence, and therefore a short preoviposition period is required. Dissection of fertilized females that died of old age after laying a large number of eggs revealed no ripe eggs in their ovaries.

Unfertilized females

Sixty-seven females of the laboratory rearings did not lay fertilized eggs. Eleven of them did not lay at all and the rest laid unfertilized eggs (622 maximum) that dried up several days after being laid. These 67 females laid a total of 10,659 eggs — an average of 159 eggs per non-fertilized female. A comparison with Table IX reveals that they laid much fewer eggs than the fertilized females.

The sex ratio

The sex-ratio of 816 adults that emerged in our rearings was equal (49.4% females and 50.6% males) and did not change in the various generations.

ANNUAL CYCLE

From an epidemiological standpoint it is important to note that 6 generations from birth to laying half the eggs develop annually. During the summer the span of such a generation lasts 36–40 days, and during the winter — more than 100 days.

The Jasmine Moth is characterized by complete overlapping of generations: in every season we can expect the appearance of all the stages, and on every day of the year there is a theoretical possibility of eggs hatching and young larvae appearing, on condition that the food situation makes this possible.

TABLE X

Mortality in the various generations: number of larvae, pupae and adults developing from 100 *eggs laid in the coastal plain*

Generation	Months	Larvae	Pupae	Adults
1	I-IV	84	39	34
2	IV-VI	94	68	84
3	VI-VII	87	62	57
4	VII-VIII	92	62	54
5	VIII-IX	84	53	50
6	IX-XI	84	48	40

Total mortality in the various generations

On the basis of the data on natural mortality among the various stages of development in our rearings (Tables II, V, VII) the total mortality in each generation was calculated. The results are summarized in Table X. The greatest increase in Jasmine Moth population occurs in the spring (2nd generation), and the adults of that generation lay the highest number of eggs.

It should be noted that in the rearings the insects were kept in better than natural conditions, being protected from the influence of extreme climatic factors (precipitation, direct solar radiation, wind) and from negative biotic factors (predators, parasites), and they were kept in excellent food conditions. Therefore it can be assumed with certainty that the mortality under natural conditions is greater than that observed in the rearings.

Phenology in the Northern Negev

The average temperatures in the Northern Negev are not very different from those in Rehovoth. Actually a monthly survey that was conducted in 4 olive groves in this region showed that the sequence and overlapping of the generations in the Northern Negev are similar to those in the coastal plain. Individual larvae of different ages were found in the groves in every season of the year. Their existence was conspicuous beginning with the month of February and their heaviest attacks occurred during the months July–October. The various generations are not distinct, but overlap: the appearance of large populations of the pest always follows the appearance of young growth on the olive trees and every neglect in carrying out control measures.

THE HOSTS

The Jasmine Moth is known as a pest of various plants of the Oleaceae. We tried to rear the larvae on the 13 most prevalent species of this family in the country. The rearings were carried out by the same method used for rearing the larvae on young olive leaves.

The larvae developed properly on the following species:

Olea europaea L.
Ligustrum japonicum Thunb.
Ligustrum sinense Lour.
Jasminum sambac Soland. in Ait.
Fraxinus americana L.
Phyllyrea media L.
Ligustrum ovalifolium Hassk.
Ligustrum lucidum Ait.
Jasminum azoricum L.
Jasminum officinale L. var. *grandiflorum* Bailey
Fraxinus syriaca Boiss.

The larvae did not develop on the following species:
Jasminum mesnyi Hance (= *J. primulinum* Hemsl.)
Jasminum humile L.

Duration of development and mortality on various hosts

Ligustrum ovalifolium which serves as a hedge is the most widespread in Israel of the hosts that were examined, with the exception of the olive. Therefore the duration of development of 218 larvae was examined on this plant. The average durations of development (at 21°–27°C) were identical with those obtained in rearings on olive foliage. The mortality among the larvae reared on *L. ovalifolium* was as follows: 8.3% in April, 10.3% in July, 14% in September and 33% from October to November. A comparison with Table V shows that in every season the mortality was lower than that of larvae reared on olive foliage.

Table XI (p. 107) summarizes data on natural mortality and average duration of development of the larvae on the various hosts. The rearings were all conducted during the months of May–June, and in all of them we tried to maintain identical conditions. Therefore they are worthy of serving as a basis for comparison, despite the relatively small number of data.

The shortest duration of development and the lowest natural mortality were obtained from rearings on foliage of *Fraxinus syriaca* and *Ligustrum japonicum*.

It is of interest to note the fact that on old leaves of *Jasminum sambac*, several seasons old, there was a more rapid development and a lower mortality than on young leaves of the same species.

DAMAGE AND PROBLEMS OF CONTROL

On the olive trees the young larvae fasten several leaves together and gnaw the mesophyll and one epidermis. Larger larvae live individually and gnaw whole leaves and even tender stems. Severe damage may be caused by very young larvae who penetrate the apical buds and gnaw them. As a result of this, the branch no longer continues to grow in length but branches out and in the next season will bear a lower yield than usual. The damage is greatest in the nursery. Young grafts may be destroyed completely as a result of the feeding of the larvae. Even an adult tree may suffer from a serious attack to the extent of all the young growth being consumed and decrease in yield. Damage of Jasmine Moth larvae to olive fruits is rare.

It is easy to recognize an attack of Jasmine Moth larvae by the severe gnawing, the webs and by the many black faeces.

Since the generations are overlapping there is, as mentioned before, a possibility of the appearance of young larvae every day of the year. Every appearance of young growth and every neglect in carrying out control measures may be followed by an attack. It is impossible to foresee the appearance of the larvae. The damage caused by the young larvae that penetrate the apical buds is serious, and therefore there is no alternative but to conduct frequent observations in the grove and to carry out control measures immediately on the appearance of the first larvae. There is no technical difficulty in the control of the larvae: the usual stomach and contact poisons kill them efficiently.

In our rearings the larvae damaged *Jasminum sambac* flowers, and succeeded in completing their development on the inflorescences of *Ligustrum lucidum*. Damaged flowers fall off. The damage to the leaves of the various hosts is similar to that of the olive leaves. On certain species the larvae are capable of gnawing even old leaves.

NATURAL ENEMIES

From Jasmine Moth larvae that were collected in olive groves, the following parasites were reared:

Apanteles lacteicolor Vier. (Hym., Brac.)
Apanteles laevigatus Ratz. (Hym., Brac.)
Ctenophorocera pavida Meig. (Dipt., Tach.)

Parasitism among the larvae that were collected in the Northern Negev was always very low.

Large populations of a green Lacewing, *Chrysopa* sp., were found in the olive groves of the Northern Negev. The larvae were capable of devouring the Jasmine Moth larvae in laboratory experiments.

ACKNOWLEDGMENTS

It is with pleasure that we extend our thanks to Dr. E. Swirsky (Agricultural Research Station, Rehovoth) for his advice and assistance throughout our work.

REFERENCES

1. Avidov, Z., 1949, The pests of ornamental plants in Israel, *Sifriath Hassadeh*, Tel-Aviv, 134 pp., (in Hebrew).
2. Bodenheimer, F.S. 1930, *Die Schaedlingsfauna Palaestinas*, Berlin, Paul Parey, 438 pp.

MICROCOCCUS BODENHEIMERI nov. spec.

H. Bytinski-Salz
Department of Zoology, Tel Aviv University

ABSTRACT

Description of a new species of the Genus *Micrococcus* from Israel: *M. bodenheimeri* By. S. Both sexes and all developmental stages are described.

Bodenheimer (1935, 1935a, 1937) reports from Palestine the occurrence of a *Micrococcus* species which he attributes to *M. similis* Leonardi 1907 described from Sardinia. A more detailed analysis of the *Micrococcus* material at hand showed that it belongs to a so far undescribed new species, which I am calling *Micrococcus bodenheimeri* in memory of F.S. Bodenheimer, the well known zoologist and student of Middle East coccids.

DESCRIPTION

Ovigerous female: 2.2-5 mm, younger specimens ellipsoidal, older specimens broader (Figure 1). Colour pinkish-brown, later, darker, always covered with a few ceriferous threads.

Young female: Holotype (on slide) 2.2mm long and 1.05mm broad; genital ring $180 \times 250\ \mu$. Body (Figure 2) ellipsoidal about twice as long as broad, segmental borders distinct.

Antennae (Figure 3) short, composed of 3 joints; 1st twice as broad as long (2:1) with 2 bristles, 2nd: 3 1/2:1 with 2 bristles, 3rd: 1.2:1, conical with a few short bristles and 10–12 apical bristles.

Eyes very small consisting of one stemma only, situated slightly ventrolateral of the antenna. Mentum triangular with one lateral and 3 apical bristles on each side, the inner one very small.

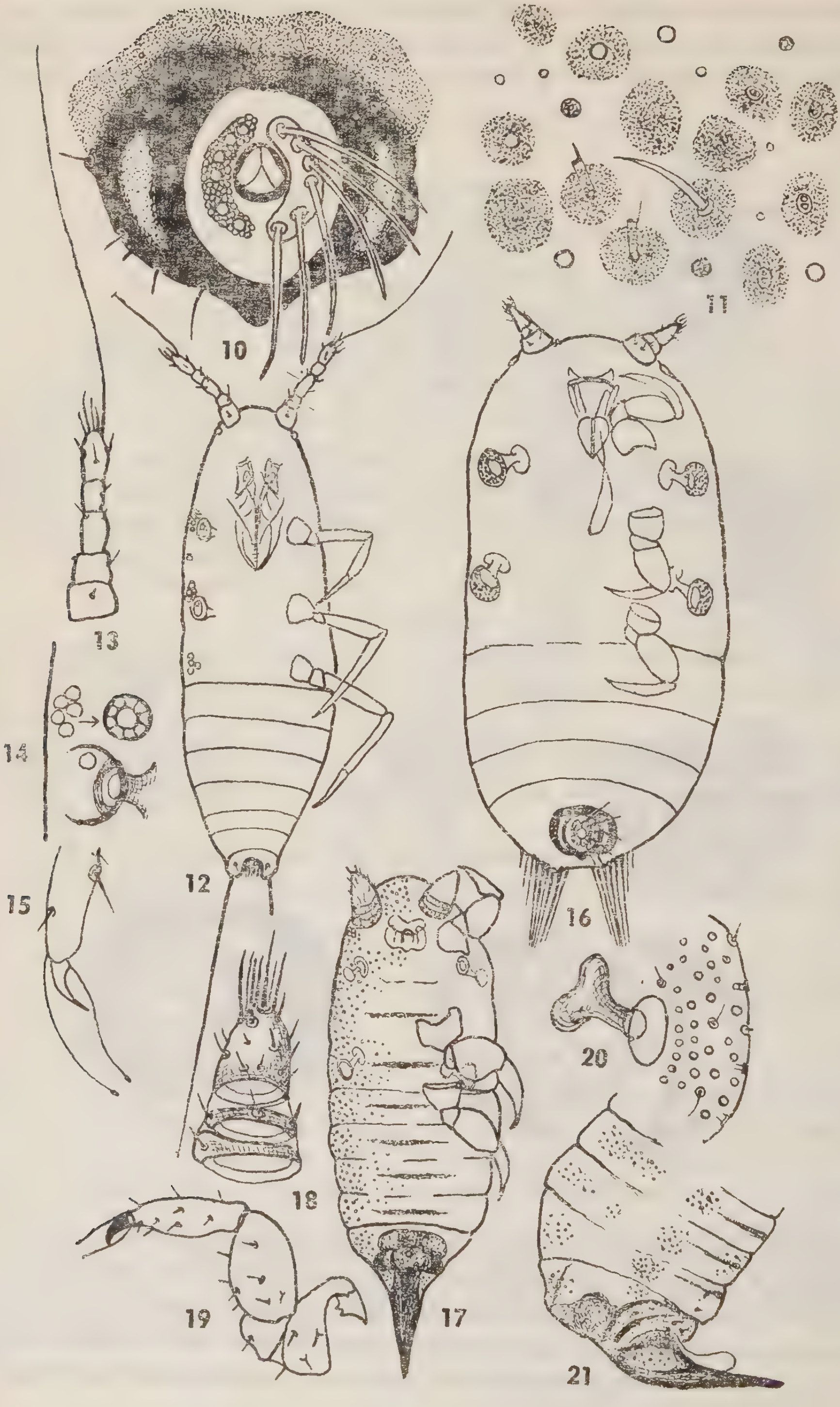
Legs (Figure 4) short and stout, coxa and trochanter with one hair each; femur rectangular with 3 hairs, tibia as long as the femur broad, cylindrical, thrice as long as broad with 2 hairs, tarsus one-jointed, 2/3 as long as the tibia; tarsal claw slender, dorsal digituli only as long as the claw, ventral ones slightly longer.

Stigma (Figure 5) large, cylindrical, the atrium enlarged and heavily chitinized. Wall densely covered with many sieve pores (intrastigmatic glands) those on the outer side larger ($7\mu\ \varnothing$) with 16–19 openings (Figure 6), those towards the stigma smaller ($5\mu\ \varnothing$) with 10–13 pores arranged in indistinct rows. Outside of the atrium *no parastigmatic glands present*!

Received November 7, 1960.

Anal opening bordered by a well chitinized ring consisting of one ventral and two dorsolateral plates (Figures 8,9). Anal plates semilunar each with 6 stout and long, slightly curved bristles, densely punctured by pores (5μ ⌀). Perianal plates very

variable; in the type (Figure 8) and also in specimens from other localities the plates are separate, semilunar, the interior not sclerotinisized, so that the strongly chitinized area forms a ring. In a paratype, collected together with the type (Figure 9) and only slightly larger (2.5mm) the plates are completely fused to form a perianal ring and also the centre of each plate is heavily chitinized. In other specimens (Figure 10)


10
11
12
13
14
15
16
17
18
19
20
21

he perianal plates may be fused dorsally and ventrally but the interior of each plate emains unsclerotinisized. The progressive sclerotinisation of the perianal plates s apparently independent of age and locality, as a perianal ring may be found ven in the 2nd larval stage (Figure 16). One bristle is always present on the upper dge of the inner unsclerotinisized area, or if the plate is completely sclerotinisized n the corresponding place (Figure 9). 4–5 lateral bristles on the outer side of each erianal plate. Anal lobes indistinct, each with a group of 6 long and 2–3 shorter ateral bristles.

Derm covered sparingly with hairs, those on the head and lateral parts of the bdomen denser and longer (45–70μ), those on the other parts of the body shorter 22–34μ). Fine spicules (Figure 7) 2.6–3.4μ long present all over the body.

Ducts and pores (Figure 7): All ducts and pores mentioned thereafter more or ess evenly distributed all over the surface of the derm. Large circular oral collar lucts 6–7$\mu\varnothing$, small unilocular pores 2.5$\mu\varnothing$, geminate (8-shaped) pores 3$\mu\varnothing$, rilocular pores (rare) 3.4$\mu\varnothing$, multilocular pores 5–6$\mu\varnothing$.

Mature female: 2.8–5 mm broader, almost circular, proportions of organs as in he young female, but additional sclerotinisations in the perianal ring especially n an anterior direction (Figure 10 stippeld), and in the derm, (Figure 11).

Oval to round sclerotinisations (17 × 12μ to 20 × 15μ) around the geminate ores (Figure 11 to the right) especially abundant in the anterior body region reaching ack to the posterior stigmata. Circular patches (17–20$\mu\varnothing$) around the rim ducts (left nd below), sclerotinisations around multilocular pores 16–19μ and on the base f the hairs (middle). Other sclerotic patches occur sparingly also where apparently o ducts or pores are present. It should however be emphasized, that also in heavily clerotinisized specimens the majority of ducts and pores remains always without clerotinisation.

Male: 1.6×0.5 to 2.2 × 0.8 mm (on slide) (Figure 17). During life, colour pinkish rown; body curved ventrally, with tip of the abdomen pointing forwards; body longate, appendages short and stout; segmental borders very distinct.

Antennae (Figure 18) 150μ long, 3-jointed, the 2 basal joints annular the 3rd onical, slightly longer than broad. Basal joints with 2–3 bristles, 3rd joint with more nd a group of 8–10 longer terminal bristles of which one is longer and stronger han the others.

Eyes dorsal of the antenna.

Mouthparts rudimentary, stylets absent.

Legs (Figure 19) well developed with many short bristles; hindleg 430μ long tibia-arsus united, rather broad (2.5:1), both spatulate bristles almost twice as long as he claw.

Stigma (Figure 20) dumbell shaped, atrium not enlarged, without intrastigmatic lands also no parastigmatic glands present.

Anal opening (Figures 17, 21) within a heavily sclerotinisized area; lateral 2

heavily sclerotinisized perianal plates, above them 2 less sclerotinisized dorsolateral perianal plates, Anal ring extending caudally into a long and strong spine-like copulatory organ in which the bulbose phallus is inserted (Figure 21). Base of the copulatory organ covered with small short spines.

Derm sparingly covered with short hairs, those on the sides of the 7th abdominal segment longer and more concentrated. Fine spicules are rare; a transverse sclerotinisized band present on the ventral side in the middle of abdominal segment 1–7 (Figure 17). Large oral collar ducts present in great numbers all over the body, especially concentrated in the anterior region between the antennae and on the sides of the thoracal and abdominal segments. Indistinct transversal rows also across the posterior borders of each segment. All other types of pores and ducts found in the female also present in small numbers.

DEVELOPMENTAL STAGES

Egg: The young ovarial egg is oval and reaches a maximum size of 424 × 235 μ. The embryo which develops within the female stretches the thin transparent chorion of he egg up to 660 × 248μ and the egg with the fully developed embryo is at birth apparently actively extruded by the female; the larva hatches after a short time (few minutes to 3 hours).

First stage larva: (Figure 12) Body elongate 710 × 220μ (on slide). Appendages well developed, body segmentation distinct.

Antenna (Figure 13) 130μ long, 5-jointed, the two basal joints broader than long, the third the longest, the last tapering towards the apex with a number of terminal hairs and one extremely long bristle which is twice as long as the antenna.

Eyes rather large, situated behind the antenna.

Mouth parts with apparently very short stylets.

Legs well developed (350μ long) coxa narrow, trochanter trapezoidal, femur not much broader than the tibia, tibia and tarsus elongate. Spatulate setae (Figure 15) almost 3 times as long as the claw.

Stigma (Figure 14) feebly chitinized, atrium not sclerotinisized with one typical intrastigmatic pore (6 ∅) and a group of 4–5 similar parastigmatic pores anterior-lateral of it. One single multilocular pore also near the hindborder of the 1st thoracic segment and another group of 4 pores lateral of the 3rd coxae (Figure 12).

Anal ring feebly chitinized bearing about 6–8 short bristles.

Anal lobes well developed, bearing a very long terminal seta about 60% as long as the body.

Derm with a few short and slender setae and inconspicuous pores.

Second stage larva: (Figure 16) pinkish-brown, ovate elongate 1.7 × 0.8 mm; Length of the antenna 150μ, of hindleg 500μ, genital ring 150 × 200 μ.

Almost identical with the immature female. Differs besides the smaller size of its organs by the tibiotarsus which is not divided and by the anal lobes which have equally long bristles and 2–3 shorter lateral ones.

In the 2 specimens avaiable from the same locality (Tivon) both have the perianal lates fused into a ring, but in one specimen the plate is completely sclerotinisized, vhile in the second (Figure 16) the elongate transparent window is very evident.

Holotype: immature ♀ Tivon 6.II.56 on grass roots (on slide).

Allotype: ♂ Oranim 25.III.54 on grass roots in *Tapinoma* nest (on slide).

Paratypes: ♀♀ immat. mat. larva II, ♂♂ Tivon 6.II.51–III.58 on grasses beside *'apinoma* nests; Oranim ♀♀ imm. mat. ♂♂ 25.III.54; Raanana ♀♀mat. 10.II.41 ɩishon le Zion ♀♀ mat. 11.IV.52 on grass roots associated with *Tapinoma phoeni-ium*; Jerusalem–Bet Hakerem ♀♀ mat. 5.IV.45; Gal On ♀♀ imm. mat. larva I (bred) n roots of *Phalaris* attended by *Tapinoma phoenicium*. All types in the collection f the Department of Plant Protection, Ministry of Agriculture, State of Israel.

DISCUSSION

The genus *Micrococcus* which now contains 5 species is restricted to the Mediter-anean region, the species occurring in Italy, Sardinia, Morocco, Algeria, Tunisia nd Israel. All species feed on grass roots, at least some of them on annual species.

According to Balachowsky (1936) *Micrococcus bodenheimeri* By.S. should be laced near *M. dumonti* Bal. which also lacks parastigmatic glands. It differs from he very short description of this species by at least the antennae, which, in *M. lumonti* have "le 3ᵉ et dernier article des antennes largement spiniforme". it differs, rom the second group with well developed parastigmatic glands, which comprise species: *M. silvestrii* Leon. *M. similis* Leon. and *M. rungsi* Bal. besides the absence f parastigmatic glands in many characters: From *M. silvestrii* by much shorter ntennal joints, shorter and stouter legs and by the perianal plates which in this species re fused dorsally; from *M. similis* by the shorter antennae, shorter and stouter gs and the smaller number (12) of setae on the anal ring which in *M. similis* is 22; rom *M. rungsi* it differs by the longer antenna, triangular mentum, much shorter patulate setae of the tarsus and claw, the absence of the two small ventral perianal lates etc. Also the ♂♂ of *M. bodenheimeri* and *M. silvestrii* (Leonardi 1920 Figure 11, Silvestri 1939 Figure 674) differ in their genital apparatus.

It is of phylogenetic interest to note, that though the 2nd stage larva and the dult ♀ of *M. bodenheimeri* lack parastigmatic glands, these are nevertheless present n the 1st stage larva in the form of multilocular pores. If the sieve pores of the adult hich are found inside and outside of the atrium of the 3 species mentioned above, ave developed from these multilocular pores it seems evident , that in *M. dumonti* nd *M. bodenheimeri* they have been secondarily lost during ontogenesis.

BIONOMICS

Micrococcus bodenheimeri develops one annual generation as probably all other *Micrococcus* species. Immature ♀♀ are found during winter and ovigerous ♀♀ up o the end of March/beginning of April. They suck on the roots of young *Grami-aceae* and in the majority of cases are found in the periphery of nests of the ant

genus *Tapinoma* (*T. phoenicium* and *T. israelis*). Bodenheimer (1935) mentions *Lasius* as host in Jerusalem, a record which ought to be confirmed. Immature ♀♀, ♂♂ and 2nd stage larvae are often found under stones within the confines of the ant nest itself. The ♀♀ lay several hundreds of eggs which are embedded in a very loose network of ceriferous wool. Probably the 1st larval stage estivates, apparently without taking up food and development starts only after the germination of grass seeds after the first winter rains. Laboratory breedings have so far not succeeded.

REFERENCES

Balachowsky, A., 1936, Contribution a l'étude des Coccides du Nord Africain (15me note), Remarque sur les *Micrococcus* paléarctiques, *Bull. Soc. Ent. France*, 163-165.
Bodenheimer, F.S., 1935, *Animal life in Palestine*, Jerusalem, p. 307.
Bodenheimer, F.S., 1935a, Studies on the zoogeography and ecology of palaearctic Coccidae I–III, *Eos*, 10, 251.
Bodemheimer, F.S., 1937, Prodomus Faunae Palestinae, *Mem. Inst. Egypte*, **33**, 220.
Leonardi, G., 1920, *Monografia delle Cocciniglie Italiane*; *Portici*, pp. 442–450.
Silvestri, F., 1939, *Compendio di Entomologia applicata*, **1**, 702–704.

EOSALTUSAPHIS BODENHEIMERI N.SP. (HOMOPTERA, AHIDIDAE)

D. HILLE RIS LAMBERS
Bladluisonderzoek T.N.O., Bennekom, Netherlands

ABSTRACT

The new aphid genus *Neosaltusaphis*, with its type, the new species *N. bodenheimeri*, is described. The host plant presumably is a *Carex* sp.

Neosaltusaphis n. gen.

esembling *Bacillaphis* Quednau, 1954, but with the posterior corners of VIIth od. tergite and the anterior corners of the pronotum developed into processi. Dor-l hairs scarce, minute as in *Bacillaphis*, but spathulate in shape. Triommatidion 'ocular tubercle") slightly developed. Typus generis *Neosaltusaphis bodenheimeri* ov. spec.

DISCUSSION

he genus belongs in the tribus Thripsaphidini of Quednau. The tibiae have normal ases and there is no trace of a patellum-like structure. The accessory rhinaria djoin the primary rhinarium on the last ant. segment. The empodial hairs are broadly liate. The dorsal hairs are of the same type as those in *Bacillaphis* Quednau, but of e "umbrella" only a very small sector is left. Long, thick rod-shaped hairs are ly present on the front, and marginally on abdominal tergites VII and VIII. he shape of the VIIth abdominal tergite is not known from other aphids.

Neosaltusaphis bodenheimeri n. sp.

pterous viviparous female.

Morphological characters (from one specimen). Body at least 3 times as long its maximum width, narrow-elliptical, depressed. Tergum hardly pigmented, ightly yellowish, sclerotic, with very flat, rather large papillae giving an alveolate opearance on most of the dorsum, but head nearly smooth and VIIIth tergite with naller papillae or large nodules; VIIth and VIIIth tergite and anterior part of head entrally submarginally with numerous rather sharp nodules. No visible sutures esent between meso- and metanotum and between abd. tergites II–VII. The stout, lindrical, hollow, thin-walled, often collapsing hairs on the front and abd. tergite II and VIII with mostly slightly widened, flattened and incised apices, on large ckets and often placed on low tubercles. "Microchaetae" (the remaining dorsal irs) very small, bent near base, spathulate, quite flat, with rounded, serrated ices, in lateral view seemingly rod-shaped; groups of spinal, pleural and marginal irs still recognizable, the Ist abd. tergite with some 24 microchaetae. Antennae

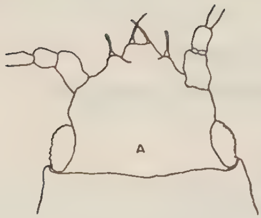


Figure A
Head and anterior edge of pronotum

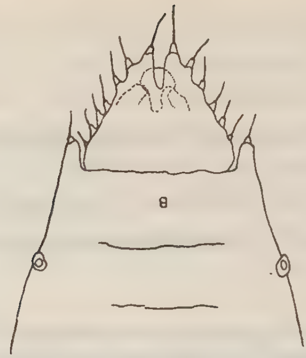


Figure B
Posterior abdominal segments of *Neosaltusaphis bodenheimeri* n.s.p.

on the flagellum with rings of spinules, up to the apex of IIIrd segment pale like th head, from there suddenly darkening to black towards apex, without secondar rhinaria, with the accesssory rhinaria on VIth segment laterally against the primar rhinarium. Hairs on flagellum thin, acute, about half as long as diameter of III segment at its strongly constricted base, very scarce; IIIrd segment with 4–5 hair IVth with 2–3; Vth with 2; VIth with only one, near the rhinaria. Front strongl protruding, reaching well past the apices of the Ist antennal segments; the later hairs on broad, strong tubercles; eyes with small triommatidion ("ocular tubercle" seemingly completely sunk into the sides of the head because between their anteri margin and the antennal base a low, granulated processus bulges, while below th posterior margin a processus on the anterior edge of pronotum protrudes. Rostrum ver short; the very short, quite acute apical segment with 6 hairs. Margin of pronotu on anterior half with a ridge gradually increasing in altitude and terminating i a scaly fingertip-like processus jutting forwards and slightly downwards. Siphuncu on the middle of VIth abd. tergite, thin, shortly cylindrical, rimless, ringed with litt scales. Posterior corner of VIIth abd. tergite with an imbricated, short, finger-lik processus directed straight backwards; the inner side of this processus convex, th outer side straight to slightly concave; on the outer apex a stout hair on a larg socket. VIIIth tergite elongated semi-oval, with a very deep parallel-sided apic incision or rather with two large, very thick-based processi at apex, with along i posterior margin on very stout bases on each side 6–7 stout hairs increasing in siz towards the apex of the segment. Legs normal, the coxae rather small and like th bases of the nearly cylindrical femora with some quite long, fine hairs; tibiae wit normal bases, with transverse rows of rather blunt spinules, on inner side with rath long hairs, or basal half on outer side with very short hairs that become long towards apex of tibiae; first tarsal joints with 5 hairs, the middle one 1/3 of th length of the inner pair, 1/2 the length of the outer pair; empodial hairs broad foliate.

Colour: Straw-coloured with distal half of antennae black.

Measurements (in mm): Length of body: 2.30; of ant.: 1.12; diam. of siphunculi:)35; length of cauda: 0.10. Ant. segments: $\underbrace{0.32}_{\text{III}}$, $\underbrace{0.16}_{\text{IV}}$, $\underbrace{0.17}_{\text{V}}$, $\underbrace{(0.15 + 0.17)}_{\text{VI}}$.

nbryones.

Owing to the corrugated sclerotic tergite very difficult to examine; marginal, eural and spinal hairs on abdomen not duplicated, of quite the same shape as the crochaetae of adults. The long hairs on front and the single pairs of large marginal irs on abd. tergites VII and VIII acute or subacute. Last antennal segment with e hair near the rhinaria.

DISCUSSION

n 26.VII.60 one specimen of this remarkable aphid was swept in a wet meadow rth of the road Knittelfeld — Neumarkt in Austria, 100 m west of a spot where e road is tightly squeezed between the river to the north and the rocky side of the ilroad to the south. The meadow near the road had a dense vegetation of either *Scirpus* of the *Maritimus* type or a tall *Cyperus*, among which grew *Carex gracilis* ith *Bacillaphis picta* H.R.L. and *Thripsaphis thripsoides* H.R.L.), grasses (with e very rare *Schizaphis nigerrima* H.R.L.) and an *Iris* sp. The collectors were Dr. d Mrs. van den Bosch from Riverside, California and the author.

In life the insect looked like *Thripsaphis leporinae* Börner (= *Thripsaphis verrucosa* ill.), for which it was mistaken. Recognition of mounted specimens is very easy.

The type is deposited in the author's collection.

name this species in memory of Prof. Dr. F.S. Bodenheimer, in gratitude for s friendship and encouragement and in admiration of his fascinating contributions biological science.

THE PHENOLOGY OF *PRODENIA LITURA* F IN ISRAEL WITH REFERENCE TO ITS OCCURRENCE IN THE NEAR EAST AT LARG

E. RIVNAY

Agricultural Research Station, Rehovoth

INTRODUCTION

Prodenia litura is one of the most serious pests of field crops in the Middle East It is the most destructive insect to peanuts, alfalfa, sugar beets and tomatoes in Israel Next to *Earias insulana* it is the most injurious to cotton, and on some occasions eve surpasses it. Lately damage to raisin grapes has been caused by having the petiol of the besries gnawed, resulting in a premature fruit drop. Although this pest is s well known, its phenology is little understood so far. This study was undertake with the aim of elucidating the pattern of its occurrence in Israel. It is based upo surveys of crops liable to be attacked by larvae and upon light trappings of adults.

FIELD SURVEYS

Twelve fields of alfalfa, clover, and peas were surveyed systematically for thre years—1957–1960. The fields were located all over the country, as follows: one a Gilat (Northern Negev), six in the Coastal Plain, three at Beit Dagan, and three a Beer Tuvia; one near Mt. Carmel on the Coast, two in the Jordan Valley, and two i Upper Galilee. The survey consisted of bi-weekly visits and each time 100 sweeping with a net over the field were carried out. Mature larvae usually hide during th day in the ground, but young larvae could be caught in this manner (Table I). Th fields were not all equally infested. Some fields in the north were free from the pes during the fall and winter, while others contained but few larvae. Tabulation wa made therefore from fields in the southern part of the country, as the pest was more prevalent there.

In addition to these leguminous fields counts were made in sugar beet fields durin 1959 and 1960 at Beit Dagan and Beer Tuvia. The number of larvae was counte on 50 plants picked at random on bi-weekly visits.

Overwintering

Larvae of *Prodenia* appear as dense populations only towards the end of June Bodenheimer (1935) says that "*Prodenia* abounds in the summer", Shweig (1956 says that the moth passes the winter in the pupal stage. According to Shweig "th

Received December 20, 1960.

st spring generation is very inconspicuous, while the second generation which pears towards the end of June is very well noticeable".

From the surveys of leguminous field crops as presented in Table I it is noticed that these crops larvae may be found in the field as late as November; their number creases during the winter months of December–March they are hardly to be und in the fields. The first renewed appearance is by the end of April. The 200 vae found in Beit Dagan (Table I) were newly hatched larvae.

TABLE I

'ourse of infestation of alfalfa and clover fields 1959–1960 *by* 100 *sweeps in each field each time*

	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX
Beer Tuvia	6	0	0	0	0	0	0	153	25		400
Beit Dagan	45	3	1	0	0	200	0	6	28	130	

the summer advances, the population increases steadily and the larval population comes more and more numerous. From the counts made in beet fields (Table II) s apparent that many larvae may be found in the field as late as January. It may also noticed that a renewed infestation takes place in May.

TABLE II

urse of infestation of beets, based on biweekly inspections — 50 *plants counted in each inspection*

	XII	I	II	III	IV	V	VI	VII
Beer Tuvia	80	37	3	0	0	17	38	25
Beit Dagan	51	5	0	1	0	16	4	28

The summer infestation

e occurrence of larvae in irrigated fields from June to November has been own for many years. As the beets mature and become less attractive, the moths posit in alfalfa, peanuts and cotton fields. The intensity of the attack depends on the age of the crop, its proximity to other infested fields, and upon the preval-ce of egg laying moth swarms.

n the alfalfa fields the larvae hide during the day on the ground between the nts, as many as 18 larvae were found on 100 cm^2. At night they are active, crawl the plants and defoliate the crop.

On peanuts they feed on the soft leaves at night, and hide under the spreading nt during the day. As many as 50 larvae have been found under one plant, but as ule the extent of infestation is less as seen in Table III. When the at tackis very ere and the foliage has become rough, larvae penetrate into the ground to feed on the soft seed within the pod. On cotton, the neonate still congregate larvae

feed on the leaves, at first leaving the veins, then eating the entire leaf — numero larvae may defoliate the entire plant. However, very often larvae leave the leaves inta and prefer the buds, flowers and young squares. This was observed on many occasio throughout the country. In one place in the Jordan Valley counts were made, which a presented in table IV. Here it was evident that the flowers were the most preferred part.

TABLE III

Extent of infestation of beets and peanuts by Prodenia *larvae*

Host plant	Date	Locality	No. of larvae per plant					
			0	1–4	5–10	11–20	21–30	31–40
Beet (30)	1.VI.59	Gilat		26	4			
Beet (200)	7.XI.60	Yavne	74	83	37	4	2	
Peanut (50)	18.VIII.59	Zmoroth	3	26	17	3	1	
Peanut (50)	21.VIII.59	Yibne	1	4	18	16	4	5

TABLE IV

Infestation of cotton by Prodenia *larvae in the Jordan Valley, August* 1959.

Part of Plant	Total number	Number infested	Percentage attacked
Flower buds	1166	207	17.75
Flowers	193	101	52.30
Squares of bolls	553	97	17.51

Build up of population

As shown in Figure 1, *Prodenia litura* is capable of raising one generatio each month under the climatic conditions prevailing during the summer in Israe Therefore, the summer infestation is not the result of a single attack, but rather c renewed successive infestations. Furthermore, the renewed egg laying does nc necessarily derive from a locally built-up population (i.e. from the same field), bu rather from invading moths or caterpillars coming from neighbouring fields, or eve more remote regions, as will be discussed below.

The course of infestation of cotton fields in Israel may serve as an example. Th fluctuations in the number of larvae in three cotton fields in Israel were studie during 1959 and 1960. Counts were made every week or even five days, and the num ber of larvae found on 60 plants, chosen at random, was recorded.

The records for 1960 presented in Figure 1 show that in the Jordan Valle (line J. Figure 1) three generations developed in the cotton field during July, Augus and September. In Gilat, Northern Negev (line N. Figure 1) the first generation i June was small and inconspicuous, the second and third were far larger and reache a level, where about 200 caterpillars were found on 60 plants. In Gederah, the Coasta Plain (line G, figure 1) there were also three generations, but no sign of demarcatio

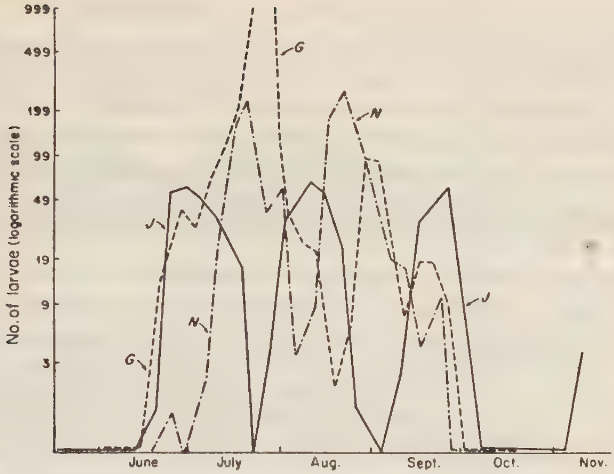


Figure 1
Infestation by *P. litura* of cotton fields in Israel in 1960. Number of larvae (in logarithmic scale) counted on 60 plants picked at random in each of three localities: Jordan Valley (line J) Gedera (line G) and Gilat (Negev) (line N).

between the first two is noticed. Here, due to continuous invasions from out of the field the heavy infestation lasted during the later half June, July and early August; at the peaks of the curve of infestation over one thousand larvae were counted on 60 plants. The third generation in September was about 10 times smaller.

Annual fluctuation of population of adults

In addition to the survey of larvae, records of flights of moths were made by means of light trapping. Some of these data are presented in Figure 2. From these records it is evident that single moths may be caught occasionally throughout the winter in Israel. Low catches continue throughout April and May, and in June the number of adults increases suddenly and large numbers of moths may be caught during the summer months till November.

However, there is no uniformity in these catches in the various localities, and no rhythm of periodicity which could be correlated with the appearance of new generations, although the moth, as stated above, may raise four or five generations during this period. This fact, the sudden abrupt increase of the number of adults in some places, as for instance in Jerusalem, and the finding that the moths were caugh in places where they could not have developed locally due to lack of host plants — Eilat, for instance, suggest that *Prodenia* is a migrant. In the light of this assumption, the phenology of the adults, as shown in Figure 2, may be explained as follows:

The isolated moths which were caught in various places in Israel during the winter months were presumably adults which developed from local overwintering pupae while the sudden increase of the number of moths is due to invading swarms at the end of May.

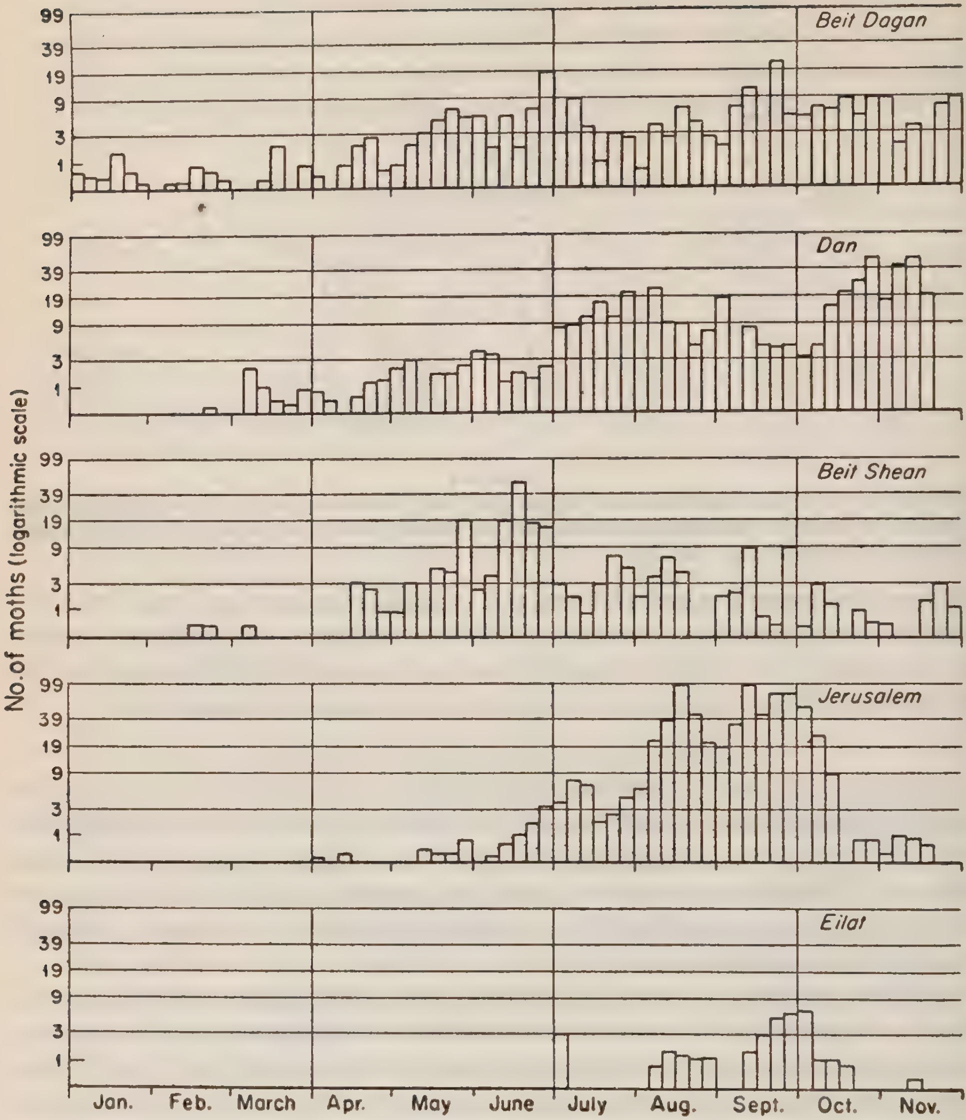


Figure 2
Flight of *Prodema litura* in Israel during 1960, as pictured by light trapping in five localities:

Beit Dagan, (coastal plain) Dan (Upper Galilee), Beit Shean, Jerusalem, and Eilat (Akkaba).

Note: (1) Prevalence of moths during the winter in the coastal plain, but not in Jerusalem and hardly in Beit Shean. (2) Decrease of number of moths in Beit Shean and its increase in Jerusalem during Aug., Sep. and Oct. (3) Prevalence of moths in Eilat only during Aug., Sep. and Oct.

Occurrence in neighbouring countries

Before discussing the origin of invading moths, a survey of their occurrence in neighbouring countries is thought useful.

Egypt.— This is the country where *Prodenia* abounds more than elsewhere in the Near East. According to Bishara (1934), seven generations develop in Egypt annually. However, while autumn, winter and spring generations are small and inconspicuous, the two summer generations — June and July, are quite large. They are 25–30 times stronger in population than the spring generations, while the increase from one generation to another during the spring is 2–3 times only. The climatic conditions in Egypt cannot explain the abrupt rise of the June generation, and the only explanation for it would be an influx of moths from remoter regions.

Sudan.— Prodenia litura according to Bedford (verbal communication) is not considered a cotton pest in the Sudan, but it is quite abundant in the Gezirah (the area between the two Niles.)

Syria.— In the list of pests published by Talhouk (1954), *Prodenia* is noted only as being of secondary importance. No reports of heavy attack are available from this country.

Lebanon.— In the list of pests from this country published by Talhouk (1950), *Prodenia* is not recorded at all as a pest.

Cyprus.— According to Chiakides (personal communication) *Prodenia* occurs in the autumn only, on rare occasions it may be considered a pest. This fact was reiterated also by Achilides in verbal communication.

Greece.— Larvae of *Prodenia* occur only in the district of Pylie, Peloponnes. This species is not considered as a pest except on certain occasions as in 1949 in Crete on alfalfa, and in 1951 in Pylie. (Vallidis, personal letter).

Iraq.— According to Wiltshire (1947) this moth is "probably migratory..." The moth is on the wing from April to November. The larva is most often seen in November.

Hypothesis as to the migration of Prodenia

The most abundant occurrence of *Prodenia* in the Near East is reported from Egypt. In his paper Bishara (1934) presented us with another very interesting graph, namely, the periodical fluctuations of *Prodenia* in Egypt for several years (Figure 3, Bishara's paper). The graph is based on collections of egg masses in cotton fields, which were compulsory in Egypt and have been recorded for many years. One should not look upon these records as absolute values, but they serve well as an indication of the abundance of egg laying females.

A glance at this graph shows us that the years 1913 and even more so 1923 were very poor in *Prodenia* population — less than 2 million, in one case, and less than one million egg masses in the other were collected then. On the other hand, in some

other years over twenty millions egg masses were collected each year. These were the peak years 1915, 1930 and 1931. It is recalled that these years were associated also with invasions of locusts in Egypt and Israel. Especially 1915 witnessed one of the severest invasions of *Sch. gregaria* in these territories.

During the last decade, Israel suffered locust invasions in 1954 and again in 1958–60. In these years there occurred also heavy infestations with *Prodenia*. We do not possess light trapping records to substantiate this statement, which is bases on frequent visits to the fields and reports coming from farmers. For other locust years during the sixth decade no *Prodenia* records are available.

REFERENCES

1. Bodenheimer, F.S., 1935, *Animal Life of Palestine*, 506 pp.
2. Bishara, I., 1934, The cotton-worm *Prodenia litura* F. in Egypt, *Bull. Soc. ent. Egypte*, **18**, 288–415.
3. Hosny, M. M. and Kotby, F.A., 1960, Host plants favoured by the cotton leaf worm moth *Prodenia litura*, F., for egg laying and their value as egg mass trap crops, *Bull. Soc. ent. Egypte*, **44**, 223–234.
4. Talhouks, S. A., 1950, A list of insects observed on economically important plants and plant products in Lebanon. *Bull. Soc. Fouad 1er., d'Entomologie*, **34**, 133–141.
5. Talhouks S. A., 1954, A list of insects found on plants of economic importance in Syria, *Bull. Soc. Fouad 1er, d'Entomologie*, **38**, 305–309.
6. Shweig, K., 1956, Vegetable Pest of Israel, **155**, *Hassadeh* (in Hebrew).
7. Wiltshire, E.P., 1957, *The Lepidoptera of Iraq*, Ministry of Agriculture, Baghdad.

SOME NEW AND LITTLE KNOWN *PHOLIDOPTERINI* (Orthoptera: Tettigoniidae) from Turkey

T. Karabag
Zoological Institute, University of Ankara

ABSRTACT
The present paper is based on the material collected in different parts of Turkey. Three new species, one new subspecies are described, and I am supplying detailed illustrations of two insufficiently known species.

The large group *Pholidopterini* has been revised by Ramme (1930,1951), but since then ̄eral additional species have been described. Recent collecting in Turkey resulted in arge material being preserved in the Zoological Instituie, University of Ankara. Its ıdy proved to be very difficult, because of variability of specific characters and a ɔrough revision of the group, with re-examination of types, is greatly needed.

In the meantime, I am able to describe below three new species, and one new ɔspecies, as well as to supply detailed illustrations of two insufficiently known ɛcies.

I extend my sincere thanks to Dr. M. Beier who kindly sent me types from the ɛnna Museum.

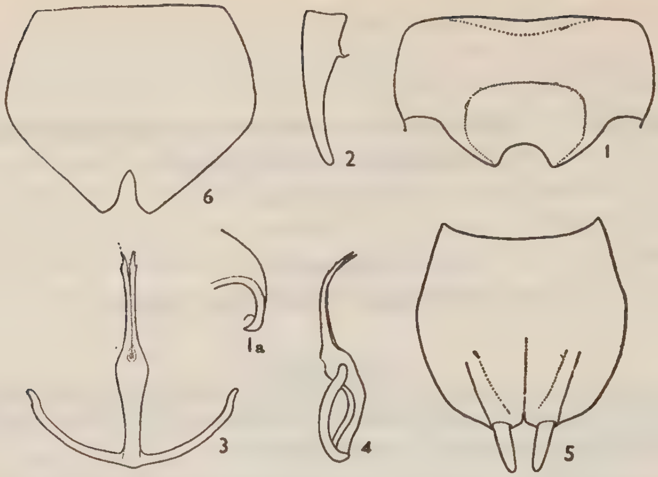
All types and some paratypes are deposited in the British Museum (Natural story); paratypes are in the Zoological Institute, University of Ankara.

PARAPHOLIDOPTERA BODENHEIMERI n.sp.

ype species). Medium size. Pronotom cylindrical, rounded behind; a shallow ɔression between mesozona and metazona; two transverse sulci, fiıst one distinct the disc and on the upper parts of lateral lobes, second distinct only on the disc. ytra short, reaching end of second tergite, veins very distinct. Last tergite (Figures 1a) with a rounded excision and strongly down-curved, with acute appendages d a depression on the apical half of surface. Cercus (Figure 2) with a small tooth the middle of the first half, slightly incurved. Titillator (Figures 3, 4) slender, second lf of its median branches very thin, middle part wider, with a few teeth near the ɛx. Subgenital plate (Figure 5) rounded, with a shallow but acute excision.

General colouration brown, with the following parts black: two parallel stripes ow antennae on the face, large and irregular spots below the eyes, a wide stripe ween eyes and fastigium, reaching pronotum, a large stripe behind eyes and ɛgular spots on the fastigium and head. Upper surface of pronotum dark brown,

ɛeived August 18, 1960.



Figures 1–6. *Parapholidoptera* **bodenheimeri** n.sp. ♂, 1. last tergite; 1a. appendages of last tergit in profile; 2. left cercus; 3. titillator; 4. titillator in profile; 5. subgenital plate. ♀, 6. subgenital plate

lateral pronotal lobes black, with light brown or yellow edge. Elytra light brown with the upper middle part and first lateral half black. Meso– and metanotum laterall mostly black. On the inside of first femur and the outside of middle femur there are irregular black spots or stripes; very dense black stripes on the first half of th outside of hind femur, a very pale blackish stripe near upper edge of inside, apica part blackish brown. Lateral side of first abdominal segment blackish brown; 2– tergites laterally blackish brown.

♀ Pronotum larger and more cylindrical than in ♂; elytra very small, scale like Subgenital plate (Figure 6) with a deep acutangular excision, its lobes subacute Ovipositor twice the length of pronotum, slender, slightly upcurved.

Colouration as in ♂.

Lengths of body in mm, ♂ 17.6 (type)– 20, ♀ 19.1–23 ; pronotom, ♂ 7.5–7. (type species)– 8, ♀ 7.5–8.6; elytra, ♂ 1–3 (part visible from above)– 2.7 (type) last femur, ♂ 17.4 (type)– 18.2, ♀ 18–20.2; ovipositor, ♀ 16.1–18.2.

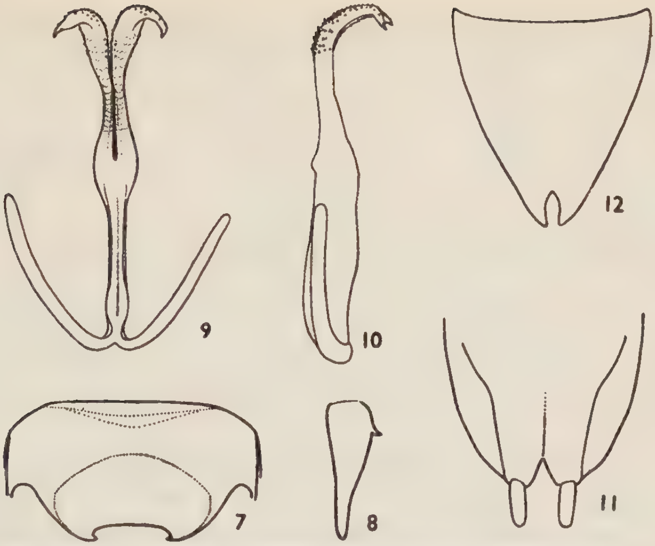
N. E. Turkey: Rize province, Ikizdere, Cimil, Demirdag, 2500 m., 31.VII.1956 10 ♂♂ (including type), 7♀♀ (T. Karabag).

This new species is superficially similar to *P. distincta* (Uvarov), 1921 from Trans caucasia and N.E. Turkey, but differs from it by the structure of last tergite, lengt and shape of cercus, but especially by titillator as can be seen from the Figures 7–12

I have much pleasure in dedicating this new species to the late Professor F.S Bodenheimer who has done so much for the exploration of Turkey.

PARAPHOLIDOPTERA DISTINCTA (Uvarov), 1921

1921. *Olynthoscelis distincta* Uvarov, *Ent. Mon. Mag.*, **57**, 3rd ser., 75, p. 49
1930. *Pholidoptera distincta* Ramme, *Mitt. Zool. Mus. Berlin*, **16**: 799.
1951. *Parapholidoptera distincta* Ramme, *Mitt. Zool. Mus. Berlin*, **27**: 213.



Figures 7–12. *Parapholidoptera distincta* (Uv.), ♂, 7. last tergite; 8. left cercus; 9. titillator; 10. titillator in profile; 11. subgenital plate; ♀, 12. subgenital plate.

N.E. Turkey: Trabzon Province, Zigana dist., 10–13.VIII.1959, 7 ♂♂, 4 ♀♀ (K.M. Guichard).

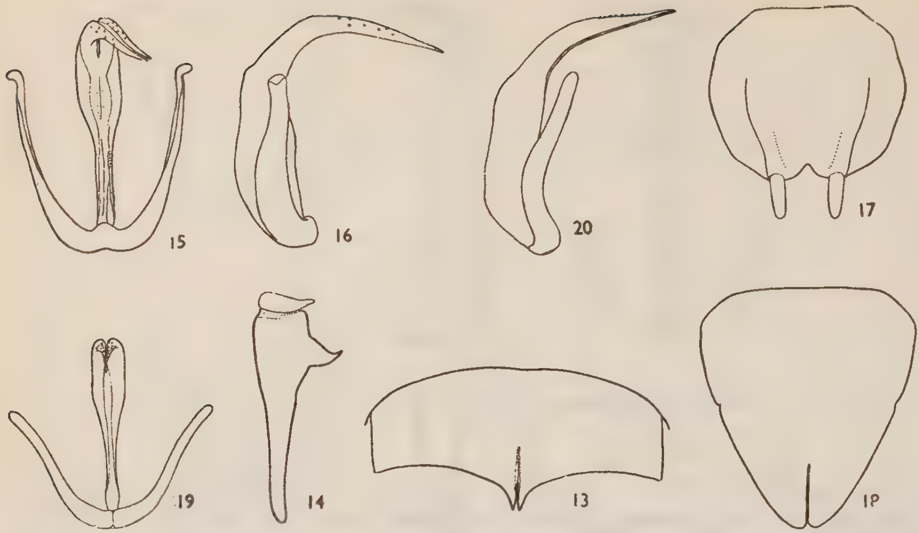
Uvarov described this species from Transcaucasia, Prov. Tiflis, without illustrations. Ramme mentioned it very superficially in 1930 and in 1951, when revising the group, he presented a figure of its titillator. The specimens collected by Mr. K.M. Guichard, have the titillator very similar to Ramme's figure, but since the type has not been studied in this respect, it is not possible to decide whether they definitely belong to *P. distincta* (Uvarov), and the figures of the last tergite, cercus, subgenital plates of male and female are given here, to assist future studies.

Lengths of body in mm, ♂ 17.6–20, ♀ 19.1–22.1; pronotum, ♂ 7.5–8.1, ♀ 7.5–8.6; elytra, ♂ 1.3–2.5 (part visible from above); hind femur, ♂ 17.3–18.3, ♀ 17.8–20; ovipositor, 16.1–18.4.

PARAPHOLIDOPTERA CASTANEOVIRIDIS FLEXUOSA n. sbsp.

1958. *Parapholidoptera castaneoviridis* Karabag, *Orthopt. Faun. Turkey*, p. 60.

♂ (type species). A large species. Pronotum long, cylindrical, mesozona slightly depressed, metazona slightly convex, posterior edge rounded. Elytra extend to the middle of second tergite. Last tergite (Figure 13) with a narrow excision and short pointed lobes, which are slightly down-curved, with their inner edges almost parallel. Cercus (Figure 14) conical, with a strong tooth near the base. Titillator (Figures 15, 16) relatively strong, basal half of median branches much narrower than apical half, apical part of median branches curved to the left (in some specimens to the right),



Figures 13–18. *Parapholidoptera castaneoviridis* **flexuosa** n.sbsp. ♂, 13. last tergite; 14. left cercus; 15. titillator; 16. titillator in profile; 17. subgenital plate; ♀, 18. subgenital plate. *P. castaneoviridis* (Br.–W.), ♂, 19. titillator; 20. titillator in profile.

much longer than the basal half, with some small spines near the apex above. Subgenital plate (Figure 17) rounded, with a short and subacute excision.

General colouration light dirty-brown (specimens preserved in alcohol); following parts are black: 4 spots on the face, two middle being longer; 4 spots on the clypeus; one short spot on the middle near base of labrum; irregularly shaped spots below the eyes and antennal sockets, a large stripe between eyes and fastigium; a wide stripe behind the eye connected near the eye with the first stripe; a stripe round the edge of fastigium; a big spot on the fastigium, a wide spot on the occiput; between those there are little black patches; some spots on the first and second antennal segments. Upper surface of pronotum dark reddish-brown; lateral lobes with light brown edge; posterior margin of pronotum black. Elytra black, their posterior edges light brown. First and second femur blackish on upper edge, and with some small black stripes; first and second tibia and tarsus blackish near apex; upper edge of hind femur blackish, along the middle a black spot, a big long spot on the inside, last tibia and tarsus blackish; some black spots on the outside of meso- and metanotum; big spots laterally on 1–4 tergites; long dark brown spot on the outside of subgenital plate near styli.

♀. Pronotum larger and more cylindrical than in ♂; pro– and metazona more convex. Elytra fully covered by pronotum. Subgenital plate (Figure 18) longer than wide, with deep and subacute excision. Ovipositor almost straight, more than twice the length of pronotum.

Colouration as in ♂, but darker and more reddish; first tergite black above; base of upper edge of ovipositor black.

BODY LENGTHS (in mm)

	P. castaneoviridis **flexuosa** n. sbsp. ♂	♀	*P. castaneoviridis* (Br. W.) ♂	♀
ength of body	22 — 26.4	28.7 — 29	25	28.9
" pronotum	9.9 — 11.3	11 — 11.8	10.7	10.8
" elytra (visible part)	1 — 2	—	1.5	—
ength of hind femur	24 — 26.6	27.2 — 27.6	26.4	28.1
" " ovipositor	—	25.7 — 26.7	—	24

ydin Province: Cine, 20–25. VII. 1950, 10 ♂♂ (including type species), 2 ♀♀ (I. Tuncay).

This new subspecies differs from *P. castaneoviridis* by darker colour and stouter ronotum, but especially by the asymmetrical titillator as can be seen by comparing igures 15, 16 with Figures 19, 20. The latter figures are drawn from the type of . *castaneoviridis* (Br. W.) from Brussa (=Bursa) W. Turkey, (Man) 1863.

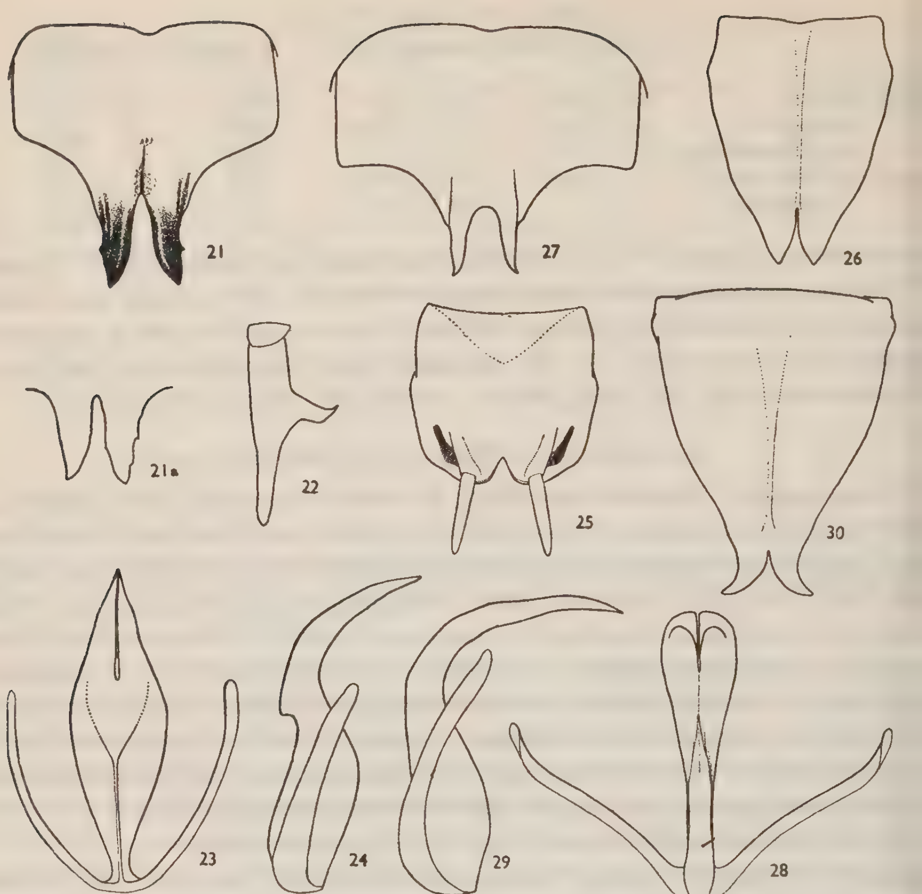
PARAPHOLIDOPTERA **INTERMIXTA** n.sp.

♂ (type species). Pronotum cylindrical, posterior edge round. Elytra almost coered by pronotum, extend to the end of first tergite. Last tergite much longer than thers, with a deep excision and strongly pointed lobes which are slightly decurved, ith the apices slightly recurved, slightly flattened, and slightly divergent, armed ith one or two short spines at the outer edge (Figure 21) (Paratype has a spine lso on the inner edge). (Figure 21a). Cercus (Figure 22) slender, with a strong and ng tooth in basal half, which is cylindrical and about twice the thickness of second alf which is conical, straight. Titillator (Figures 23, 24) very large, basal half of s median branch compressed laterally, very high, gradually flattened to the apex, s apical half gradually and slightly incurved. Subgenital plate (Figure 25) with a 1ort acute excision, styli thin and long. Hind legs relatively short.

General colouration brown, following parts are black: four spots on the face, vo of them being short stripes in the middle; two round spots on the clypeus; vo smaller and paler spots below; one spot near the base of labrum; a stripe round 1e edge of fastigium; a V-shaped stripe on the fastigium; patches and spots, on the ead; sockets of antennae; a stripe between eyes and fastigium, which continues to 1e pronotum; a large stripe behind eye. Lateral pronotal lobes black, with light lge; pro- and mesozona castaneous; metazona blackish brown. Elytra black in 1e middle part, with light-brown edge. Hind femur with a long black spot, which ontinues to the end of femur; some stripes near base between upper edge and the ack spot; upper edge light brown; a big black spot near upper edge on the inside; bia blackish brown. A big spot on the sides of first and second tergites; pointed bes of last tergite black.

♀. Pronotum more cylindrical and more convex than in ♂. Elytra completely vered by pronotum. Subgenital plate (Figure 26) much longer than wide, with deep acute angular excision and acute lobes. Ovipositor longer than hind femur, ender, almost straight.

Colouration as in ♂, but a little lighter; face creamy-brown. Uppeı surface of



Figures 21–26. *Parapholidoptera* **intermixta** n.sp., ♂, 21. last tergite; 21a. appendages of la tergite (paratype); 22. left cercus; 23. titillator; 24. titillator in profile; 25. subgenital plate. ♀, 2 subgenital plate. *P. signata* (Br.–W.), ♂, 27. last tergite; 28. titillator; 29. titillator in profil ♀, 30. subgenital plate.

pronotum blackish brown; subgenital plate light brown; a medial black stripe nea the base of ovipositor.

Maras Province; Binbuga dagi, Sariz, 8,13.VII.1952, 2 ♂♂ (including type specie (R. Cetik): Goksun, 10,13.VII.1951, 3 ♀♀ (O.K. Gulen).

This new species offers a combination of characters found in *P. signata* (Br.W

BODY LENGTHS (in mm)

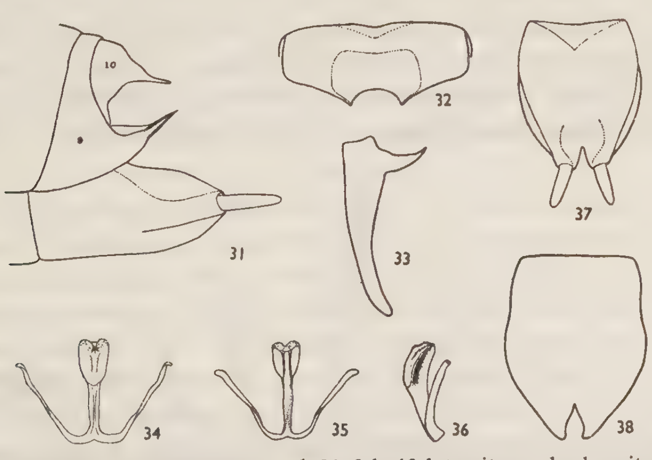
	P. **intermixta** n. sp.		*P. signata* (Br.W.)		*P. noxia* Rme.	
	♂	♀	♂	♀	♂	♀
Length of body	22.8 – 25.9	25.2 – 27	31	35.6	22 – 22.5	23.2 – 27.
" " pronotum	8.5 – 9.3	9.3 – 10.1	11.7	13.1	8.2 – 9	10
" " elytra	1 – 1.5	–	–	–	1	–
" " hind femur	21.6 – 24	24.1 – 25.7	31.4	32.5	24	27 – 27.
" " ovipositor	–	25.5 – 28.7	–	35	–	22.1

aurus, S. Turkey), and *P. noxia* Rme. (Daghestan and Armenia). Pronotum is orter than in *P. signata*, but longer and thicker than in *P. noxia*; lobes of last rgite similar to *P. noxia*, but are thicker, with rough surface and some spines; illator in profile similar to that of *P. signata*, but the median branch is wider and gher; ♀ subgenital plate similar to that in *P. noxia* but narrower. For comparison offer some figures (27, 28, 29, 30) of the type *P. signata* (Br.W.) from Gulek, — on urus (Lederer).

PHOLIDOPTERA GUICHARDI n.sp.

♂ (type species). A small species. Pronotum relatively stout; posterior edge ghtly rounded and shallowly excised in the middle; pro– and mesozona narrower an metazona; meso– and matazona flattened; median carina visible on metazona; e first and typical sulcus distinct; lateral carina distinct at the metazona; upper rface of metazona slightly rough. Elytra extend to the end of 3rd tergite. 9th rgite (Figure 31) laterally with an acute and long spine. Last tergite (Figure 32) th semi-circular excision, and a wide depression on the middle. Cercus (Figure 33) latively long, gradually incurved, with a long strong tooth near base. Titillator igures 34–36) small, apical part of its median branch wide and thick, with some nall and dense spines on the upper surface of the top. Subgenital plate (Figure) much longer than wide, with an acute excision.

General colouration castaneous, head and face uniformly light brown (in some ecimens brown). Pronotum uniformly coloured, with a single long black spot at e upper hind corner of lateral lobes, and a small black spot at the middle of the osterior margin. Elytra black, only right corner of the right elytron and some veins e light brown; a big black spot on the upper lateral sides of meso– and metanotum d first tergite. First and second legs uniformly coloured; a large black spot on the pper basal edge of hind femur; and a long black spot on the middle of first half;



Figures 31–38. *Pholidoptera* **guichardi** n.sp.,♂, 31. 9th, 10th tergites and subgenital plate in profile; last tergite; 33. left cercus; 34. titillator from front; 35. titillator from back; 36. titillator in ofile; 37. subgenital plate. ♀, 38. subgenital plate.

second half blackish-brown, lower edge whitish brown; a big blackish-brown spo on the middle third portion of inside; tibia blackish-brown; subgenital plate yellow ish-brown, its upper edge black laterally.

♀. Pronotum much longer than in ♂; pro- and mesozona more convex; metazon less rough; median carina on metazona less distinct; first and typical sulcus distinc lateral carina distinct at the metazona, posterior edge slightly rounded, mor deeply excised in the middle of posterior margin. Elytra covered by pronotum scale-like, seen only laterally, subgenital plate (Figure 38) much longer than wide with a deep and acute excision, its lobes subacute. Ovipositor shorter than hin femur, slender, very slightly curved upwards.

Colouration as in ♂.

Lengths of body in mm, ♂ 14–17.2, ♀ 21.5; pronotum, ♂ 7.1–8.8, ♀ 8.6; elytra ♂ 2.1–2.9; hind femur, ♂ 19–21, ♀ 23.7; ovipositor, 17.1.

Trabzon Province: Zigana dagi, 10–13.VIII.1959, 4♂♂ (including type species 1 ♀ (K.M. Guichard).

This new species is named in honour of Mr. K. M. Guichard, who discovere it and collected many other interesting Orthoptera in Turkey.

It differs from others of this group by the acute and long tooth on lateral lobes 9th tergite, and by the unique type of its titillator, armed with spines on its ve thick apical branch.

EUPHOLIDOPTERA TAHTALICA (Uvarov), 1949

1949. *Pholidoptera tahtalica* Uvarov, *Proc. R. Ent. Soc. London*, (*B*) **18**: 1.

1951. *Eupholidoptera tahtalica* Ramme, *Mitt. Zool. Mus. Berlin*, **27**: 198, 204.

S.W. Turkey: Tahtali dag, above Kemer, Antalya (Adalia) vilayet, 1700 m., su alpine scrub, 17.VII.1947, 2♂♂ (including type species); Antalya: Tekirova dag, 1100 m 12.VII.1949, 1♂; Tahtali dag, 1600 m., 10.VII.1949, 2 ♂♂; Kemer, Tahtali dag, 1400 m 9.VII.1949, 1 ♀; Gebiz, Bozburun dag, 1700 m., 27.VII.1949; 2♀♀ larvae; Kemer, Tahta dag, 1400 m., 9.VII.1949, 1♂ larva, 2♀♀ larvae; Calbali dag, 1200–1600 m., 15.VII.194 1 ♀ larva (P.H. Davis) (British Museum). Karabag (Orthoptera fauna of Turke 1958, p. 58) recorded it from Mugla, 1♀ (O.K. Gülen) (Zool. Inst. Ankara).

Figure 39. *Eupholidoptera taht lica* (Uv.), titillator.

This species has been described by Uvarov from S.W. Turkey, but its titillat has not been figured before and I take the opportunity of doing so, as well recording its distribution.

THE SERUM PROTEINS IN NON-HIBERNATING AND HIBERNATING HEDGEHOGS

PAAVO SUOMALAINEN AND EEVA KARPPANEN

Department of Physiological Zoology, The University of Helsinki, Finland

ABSTRACT

The relative albumin content of the hedgehog serum increases in the natural hypothermy that occurs during hibernation. In the globulin fractions of the serum no statistically significant differences were found by means of paper electrophoresis.

The great physiological importance of the plasma proteins, e.g. in the regulation of the osmotic pressure, prompted an investigation of the correlation between hibernation, with the slowing down of the heart rate (cf. e.g. Suomalainen and Sarajas 1951), and the content of the plasma proteins.

MATERIALS AND METHODS

The hedgehog, *Erinaceus europaeus* L., has been the experimental animal used in this investigation. Each animal was kept in a separate cage in an animal-room at the laboratory. The animals were fed on water, milk, whole Baltic sprats, ordinary minced meat or viscera and often, mixed with these, finely minced raw potato.

From mid-October until May the temperature of the animal-room was about +4–5 °C, and during the rest of the year it was approximately the same as the outdoor temperature.

Body temperatures were measured from the skin by means of a thermocouple.

Blood samples were taken in the morning with a syringe directly from the heart. The total protein, albumin and globulin contents of the serum were determined by the method of Reiner (1953). The fractionation of the serum proteins from other animals was made by means of paper electrophoresis according to the instructions for the use of paper electrophoresis equipment type LKB 3276. The filter paper used was the Carl Schleicher & Schüll No. 2043 B (12g/m^2) paper. The buffer was a veronal one according to Michaelis with an ionic concentration of 0.125 and pH 8.6. The voltage was 110V and the running time 16 hours. The dye solution for proteins was as follows: methanol 45 wt%, water 45 wt% and acetic acid 10 wt%. To this solution Amidoblack 10 B was added in excess, so that it became saturated with this dye. Washing was done with a solution exactly similar to the above but omitting the dye. The papers were made transparent by treatment with a mixture of alpha-bromonaphthalene and paraffin oil in the ratio 1:1. The stained fractions were analyz-

Received August 22, 1960

ed with a densitometer. The area of each piece in the densitometer curve was measured with a planimeter. The figures in Table 2 are percentages of each peak area relative to the total area between the densitometer curve and the zero line.

RESULTS

The results of our determinations of the total protein, albumin and globulin contents of the hedgehog serum in different seasons are summarized in Table I. (The figures

TABLE I
Proteins in hedgehog serum

	Total protein g/100 ml	Albumin g/100 ml	Globulin g/100 ml	Alb./Glob. ratio
In summer	7.9 ± 0.45	3.3 ± 0.51	4.6 ± 0.41	0.72 ± 0.15
(July)	(7)	(7)	(7)	(7)
	7.2 – 8.5	2.5–4.1	3.9–5.3	0.53 – 0.93
In autumn	6.8 ± 0.23	2.9 ± 0.14	3.9 ± 0.25	0.75 ± 0.07
(Late September)	(4)	(4)	(4)	(4)
	6.4 – 7.0	2.7 – 3.1	3.5 – 4.1	0.66 – 0.83
In hibernation				
Early in the winter	7.1 ± 1.2	3.6 ± 0.43	3.5 ± 0.91	1.10 ± 0.25
(Late November)	(6)	(6)	(6)	(6)
Body temperature 8.4–11.5°C.	5.1 – 8.7	3.0 – 4.5	2.1 – 4.4	0.79 – 1.43
Mid-winter	8.7 ± 1.17	4.7 ± 0.54	4.0 ± 0.83	1.24 ± 0.28
(January–February)	(9)	(9)	(9)	(9)
Body temperature 1.0–8.5°C.	6.3 – 10.4	3.9 – 5.6	2.2 – 5.3	0.96 – 1.90
Wake and homoiothermic	6.5 ± 1.10	2.2 ± 0.85	4.3 ± 0.25	0.52 ± 0.17
in winter	(2)	(2)	(2)	(2)
(November–January)	5.4 – 7.6	1.4 – 3.1	4.0 – 4.5	0.35 – 0.69
In spring	8.1 ± 0.92	3.5 ± 0.62	4.6 ± 0.78	0.76 ± 0.18
(May- Early June)	(12)	(12)	(12)	(12)
	6.2 – 9.6	2.4 – 4.4	3.7 – 6.3	0.52 – 1.04

in the tables represent the mean ± standard error of the mean, number of observations (in parentheses) and range.) The albumin content of the serum clearly increases during hibernation. The globulin content, on the contrary, decreases slightly. As is seen from Table II, which cites the means of the fractions of the serum proteins, no statistically significant differences in the globulin fractions of the serum were found.

Biörck, Johansson and Veige (1956) have also fractionated the plasma proteins of the hedgehog by means of paper electrophoresis. Raths (1957) has investigated the common hamster, *Cricetus cricetus* (L.), and Schubert, Künkel and Maass (1957) the fat dormouse, *Glis glis* (L.). All these workers have found an increase in the albumin fraction during hibernation. According to Biörck, Johansson and Veige, the beta$_1$-,

TABLE II

Albumin and fractions of globulin in hedgehog serum

	Albumin	Globulin					Alb./Glob. ratio
	%	α_1%	α_2%	β_1%	β_2%	γ%	
In summer (July–August)	31.6 ± 3.70 (5) 28.2 – 38.9	10.5 ± 0.85 (5) 8.9 – 11.2	7.1 ± 1.43 (5) 5.2 – 8.8	15.7 ± 1.62 (5) 13.6 – 17.9	19.9 ± 2.08 (5) 17.7 – 23.4	15.2 ± 3.08 (5) 11.5 – 20.4	0.47 ± 0.09 (5) 0.39 – 0.64
In autumn (October–November)	35.0 ± 3.96 (3) 30.2 – 39.9	10.2 ± 1.06 (3) 8.8 – 11.4	7.8 ± 2.08 (3) 5.2 – 10.3	14.7 ± 1.34 (3) 13.3 – 16.5	19.4 ± 3.47 (3) 16.5 – 24.3	12.9 ± 0.65 (3) 12.3 – 13.8	0.54 ± 0.09 (3) 0.43 – 0.66
In hibernation (Late November – Early April) Body temperature 1.5–12°C.	35.7 ± 3.49 (6) 28.3 – 38.7	13.0 ± 1.24 (6) 10.8 – 14.6	8.2 ± 1.61 (6) 5.4 – 10.8	12.2 ± 1.76 (6) 8.9 – 14.4	18.1 ± 1.72 (6) 15.0 – 20.3	12.8 ± 3.67 (6) 8.6 – 18.8	0.56 ± 0.08 (6) 0.39 – 0.63
Wake and homoiothermic in winter (December–January)	34.7 ± 0.78 (4) 33.5 – 35.5	11.9 ± 0.45 (4) 11.5 – 12.6	7.8 ± 0.59 (4) 7.2 – 8.7	15.5 ± 3.19 (4) 12.2 – 20.7	17.8 ± 0.98 (4) 16.7 – 19.1	12.3 ± 2.55 (4) 7.9 – 14.2	0.53 ± 0.02 (4) 0.50 – 0.55
In spring (May – Early June)	26.3 ± 4.22 (3) 20.7 – 30.9	11.4 ± 0.69 (3) 10.4 – 12.0	10.9 ± 2.26 (3) 8.4 – 13.9	18.2 ± 2.16 (3) 15.5 – 20.8	21.8 ± 1.03 (3) 20.4 – 22.9	11.4 ± 1.10 (3) 10.0 – 12.7	0.36 ± 0.08 (3) 0.26 – 0.45

$beta_2$- and gamma-globulin fractions are decreased in the plasma of the hibernating hedgehog. Since their paper does not contain the standard errors of the means, it is not possible to compare their results with ours. As a result of the cold stress, the gamma-globulin content of the common hamster, according to Raths, decreases significantly. In the fat dormouse, Schubert, Künkel and Maass likewise found a decrease of globulins. This was greatest in the alpha-globulin fraction.

It is interesting to note that the plasma albumins exert an appreciable osmotic pressure and play an important part in controlling the movement of fluid across the capillary membrane.

REFERENCES

1. Biörck, G., Johansson, B. and Veige, S., 1956, *Acta physiol. scand.*, **37**, 281.
2. Raths, P., 1957, *Zool. Anz.*, **159**, 139.
3. Reiner, M., 1953, *Standard Methods of Clinical Chemistry*, **1**, Academic Press, New York.
4. Schubert, G., Künkel, H. A. and Maass, H., 1957, *Strahlentherapie*, **103**, 368.
5. Suomalainen, P. and Sarajas, S., 1951, *Ann. Zool. Soc. "Vanamo"*, **14:2**, 1.

THE SALE-CATALOGUE OF THE CABINETS OF NATURAL HISTORY OF *ALBERTUS SEBA* (1752)

A CURIOUS DOCUMENT FROM THE PERIOD OF THE NATURAE CURIOSI

H. ENGEL
Zoological Museum, Amsterdam

ABSTRACT

The *Nederlandsche Maatschappij ter Bevordering der Geneeskunt* acquired the Sale Catalogue (1752) of the Cabinet of Albert Seba (1665–1736), the Amsterdam apothecary and author of the *Locupletissimi rerum naturalium thesauri accurata descriptio...* in four volumes (1734, 1735, 1758, 1765). After Seba's death, many difficulties delayed the editing of Vol. III and IV of the *Thcsaurus*. At last it was decided to sell the Cabinet to meet the expenses of the printing of the two last volumes.

It is interesting as an illustration of the high prices spent on natural curiosa in the 18th century and gives the names of the amateurs and brokers that bought the objects. Many of the animals are types of Linnaeus's species, and he often referred to Seba's *Thesaurus* in his *Systema Naturae*.

A description of Seba's gifts to the Church in his native village Etzel (East Friesland) is given.

When writting *The Life of Albert Seba* [Engel 1937, pp. 75–100] I often searched in vain for the Sale-Catalogue of his cabinets. Since then, the Dutch Society for the Promotion of Medicine (Nederlandsche Maatschappy ter Bevordering der Geneskunst) acquired a specimen of the first sale (1752) of part of Seba's Cabinet of Natural History.

Albert Seba was born to a farmer on the 2nd of May 1665 O.S (i.e., 13–V–1665 N.S.) in Etzel (East Friesland). The schoolmaster of the village taught him Latin and natural history. He served as an apprentice in an apothecary's shop — first (1684–5) in a little town, Neustadt–Göden, not far from his native village, and then in Groningen (1685–6), Amsterdam (1686–90), then in Nuremberg (1690–93), Strassburg (1693–96) and finally again in Amsterdam. Here he soon became a citizen and passed his examination as an apothecary in 1697. In 1698 he married 24 year-old Anna Loopes, and on the 2nd of February 1700 he bought a house on the "Haarlemmerdijk" in Amsterdam, where his shop was known as "Die Deutsche Apotheke".

He was a good merchant and knew how to make money in dealing in simples coming from the Indies and in objects of natural history, especially shells and other "curiosities", which were "en vogue" at the time with the owners of Cabinets. Shells were also much used for garden decoration.

Received September 26, 1960

His most important transaction was the sale of his Cabinet in 1717 to Czar Peter of Russia for the sum of 15,000 guilders. He at once started another collection and towards the end of his life could afford to publish a description of its contents in a work in folio, known as the *Thesaurus.* (Locupletissimi rerum naturalium thesauri accurata descriptio, et iconibus artificiosissimis expressio, per universam physices historiam. Opus, cui, in hoc rerum genere, nullum par exstitit. Ex toto terrarum orbe collegit, digessit, descripsit et depingendam curavit Albertus Seba Etzela Ostfrisius, Academiae Caesareae Leopoldino Carolinae Naturae Curiosorum Collega Xenocrates dictus; Societatis Regiae Anglicanae et Instituti Bononiensis sodalis). It was schemed in four volumes. He lived to see the publication of the first (1734) and the second (1735) volume. When he died on May 2, 1736, the plates of Volume III were ready as well as three-fourths of the text. In Seba's will, his son-in-law, Jacob Marcus, married to his eldest daughter, Margaretha, was charged with the publication of the remainder of the work, as he was interested in several sciences. However, the heirs wanted Marcus to take the Museum as part of his wife's inheritance. This he refused, and thus the execution of Seba's will was delayed. The second daughter, Elisabeth, had been married to a clergyman, Ds. Willem Muilman, but she died suddenly in 1732, leaving behind a young son, Wigbold. Seba had appointed two executors of his will for this grandchild, but these two gentlemen spent so much time in discussions with the notary and the heirs that in 1741 they had a booklet printed as a declaration of their expenses, then amounting to 5,845 guilders! It is preserved in the Amsterdam Archives, together with the 50 documents drawn up between April 1736 and April 1742 concerning this case.

The final division of Seba's inheritance took place on March 29, 1742, but this did not mean that all the trouble was over. For, when Margaretha Seba died on January 27, 1750, and her husband Jacob Marcus on April 13 of the same year, nothing as yet had been done. The library of Marcus, which included the library which he had inherited from Seba, was sold on September 7, 1750.The copper plates of Volume III of Seba's Thesaurus were covered with verdigris, many insects and other animals in the collection had been ruined by mould and insects.

Then the third son-in-law, Roeland Willem van Homrigh (married to the youngest daughter, Johanna Seba) who was an apothecary like his father-in-law and who had succeeded him in his chemist's shop, took things in hand. He obtained the cooperation of Arnout Vosmaer (1720–99), Director of the Menageries and Cabinets of his Highness the Prince of Orange (Stadtholder of the Netherlands) and together with other naturalists, viz. Johannes Le Francq van Berkhey (1729–1812), Peter Pallas (1741–1811) and Martin Houttuyn (1720–98), he tackled the difficult task of completing Seba's work so many years after his death. According to the archives of the Vosmaer family which I studied after the publication of *The Life of Albert Seba*, the French translation was begun by a certain Massuet and later on continued by one Dr. Ducloux under supervision of Professor Johannes Allamand (1716–1787)of Leiden.

To meet the expenses it was necessary to sell the Cabinet. This took place on

April 14, 1752, and following days, and it is the catalogue of this sale which is now available for study as a very interesting item for our knowledge of this curious cultural period.

Johanna Seba, the youngest daughter, died on February 17,1758, and Ds. Muilman on February 7, 1759, but Johanna's husband, Van Homrigh, persisted in his work of piety, editing volumes III and IV of Seba's *Thesaurus* in the years 1758 and 1765 respectively.

Before dealing with the Catalogue itself, it is interesting to note that it is possible to get an idea of Seba's thriving trade in medical simplicia and natural curiosities from his account in the Amsterdam Bank of Exchange, which appears from 1713 to 1742 (Archief Wisselbank nrs. 145, 202). It begins with small amounts and increases as he buys larger and larger quantities of wares from the East Indian Company. About 1718 sums of 9000, 6000 and 5000 guilders are mentioned, each representing a fortune at the time if we consider that the value of Seba's five-storey house amounted to 15,000 guilders (later on 11,000). As mentioned, he received 15,000 guilders for the Cabinet sold to Czar Peter.

Seba was grateful for his success in life. In 1713 he gave a wooden baptizing font and two paintings to the church of his native village of Etzel*, and the *Thesaurus* must be considered as his gift to the Science of his time. Many of his pictures and descriptions served as the basis of Linnaeus's descriptions in the *Systema Naturae*.

The catalogue is entitled: CATALOGUS / Van de Uitmuntende / CABINETTEN /

---

* Pastor L. Janssen in Etzel (now retired in Aurich) who is much interested in Seba and often wrote about him in his *Etzcler Uthkundiger* gave me the following description, which I was able to verify in the summer of 1960, when visiting the church at Etzel: A wooden baptising font painted in marble vein; the eight panels of the wide, about one meter high base contain paintings of eight apostles; from the base it narrows in a curved line to the top, which contains the brass basin and cover.

The two paintings are lozenge-shaped, ($5\frac{1}{2} \times 5\frac{1}{2}$ft.). One shows at the top a circle with a chalice and plate and the circumscription: "Hic procul a curis". Then follow two circles, each with a coat of arms, one with a half-unicorn and a half-eagle, the other with a white–black chequered horizontal band in a red field. In the centre of the picture is shown the Baptism of Jesus by John, flanked on one side by a circle with an alter and a lamb, circumscribed with: "Humilia respicit" and on the other by a circle with a crown and the circumscription "Corsu compleis" (sic.) Next follow two ovals with the legends: "Diese Taufe und zwei Tafeln hat zur Ehre und Gedächtnisz in diese Kirche zu Etzel verehret". — "Albertus Seba, Apotheker in Amsterdam und sijne Ehefrouw Anna Lopes, den 12. Mai 1713". It is signed "Peter van Alsem, den 3. Oktober 1713".

The second painting shows at the top a circle with the sun and the circumscription "Totus singulis". Then follow two circles, one with the monogram A S, the other with A L (meaning Albert Seba and Anna Lopes). Painted in the middle is the conversation of Jesus with Nicodemus at a table with a light and the Ark of the Covenant, flanked by a circle with the two tables of Moses and the circumscription: "Tarde custode remato" (sic) and by a circle with an open book which reads "E-van-ge-li-um" and which is circumscribed: "Pacifera Ramum praetendet oliva". The next row again contains two ovals, one reading "Deese twee Taeffeln en Doope heeft ter Ehren en Gedaghtenis in deze kerk tot Eetzel verehrt" and the other, "Albertus Seba, Apotheker in Amsterdam en sijn Huijsfrouw Anna Loopes, A° 1713, den 12. Mai Nieuwen Stijl". The lone circle at the base shows the book with the seven seals and the circumscription: "Quis apertum redet apertum?" The picture is signed Peter van Alsem.

CATALOGUS
Van de Uitmuntende
CABINETTEN,
Met allerley ſoorten van ongemeene
ſchoone Gepolyſte
H O O R N S,
DUBLET-SCHELPEN,
CORAAL- en ZEEGEWASSEN;
Benevens het zeldzame en vermaarde
CABINET van
GEDIERTENS in FLESSEN
En
N A T U R A L I A,
En veele RAARE
ANATOMISCHE PREPARATA
Van den Profeſſor RUYSCH:
Als mede een Verzameling van diverſe
M I N E R A L E N
Verſteende Zaaken, Agaate Boom-
ſteenen, Edele Geſteentens,
En verſcheide andere
R A R I T E I T E N.
Met veel moeite en koſten in een reeks van
Jaaren vergadert.
En nagelaten door wylen den Heere
A L B E R T U S S E B A,
Lid van di Keizerlyke Leopoldiſche Caroliniſche en Koningl.
Engelſche Societeit der Wetenſchappen, als ook
der Academie van Boloniën.
Dewelke Verkogt zullen worden door de Makelaars *Th. Sluy-*
ter, *J. Schut* en *N. Blinkvliet*, op Vrydag den 14. April
1752 en volgende dagen, 's morgens ten 9. en 's namid-
dags ten 3 uuren, te Amſterdam, ten huize van HUY-
BERT de WIT, Caſtelyn in 't Oudezyds Heeren Lo-
gement.
Zullende alles des Woensdags voor de Verkooping
van een ieder kunnen gezien werden.
De CATALOGUS is te bekomen by de
voornoemde Makelaars.

Figure 1
Title page of the Catalogue

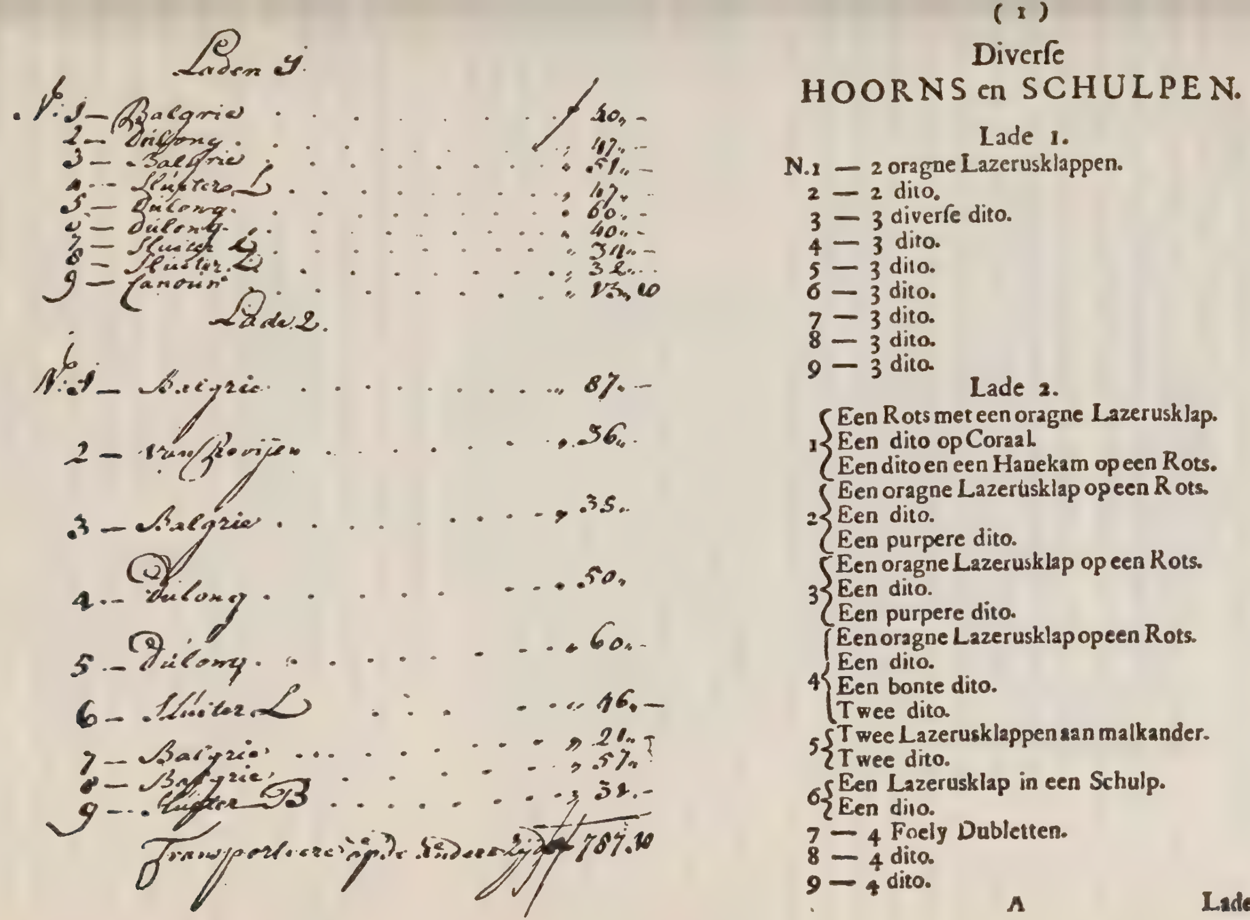
Met allerley soorten van ongemeene / schoone Gepolijste / HOORNS, / DUBLET-SCHELPEN, / CORAAL-en ZEEGEWASSEN; / Benevens het zeldzame en vermaarde / CABINET van GEDIERTENS in FLESSEN / en / NATURALIA, / En veele RAARE / ANATOMISCHE PREPARATA / Van den Professor RUIJSCH. / Als mede een Verzameling van diverse / MINERALEN / Versteende Zaaken, Agaate Boomsteenen, Edele Gesteentens, / en verscheide andere RARITEITEN. / Met veel moeite en kosten in een reeks van / Jaaren vergadert. / En nagelaten door wijlen den Heere / ALBERTUS SEBA, / *Lid van de Keizerlijke Leopoldische Carolinische en Koningl. / Engelsche Societeit der Wetenschappen, als ook der Academie van Boloniën.* / Dewelke Verkogt zullen worden door de Makelaars *Th. Sluy / ter, J. Schut en N. Blinkvliet*, op Vrijdag den 14. April 1752. en volgende dagen 's morgens ten 9, en s'namid-/dags ten 5 uren te Amsterdam, ten huize van HUY-/BERT de WIT, Casteleyn in 't Oudezijds Heeren Lo-/gement./ *Zullende alles des Woensdags voor de Verkooping / van een ieder kunnen gezien werden.* / De CATALOGUS is te bekomen bij de / voornoemde Makelaars.

TRANSLATION: Catalogue of the excellent Cabinets with all sorts of extraordinary beautiful polished Shells, Doublet-shells, Coral and Sea-Growths; together with the rare and renowned Cabinet of Animals in Bottles and Natural Products and many curious Anatomical Preparations of the Professor Ruysch: as well as a Collection of various Minerals, Petrified Objects, Agate Dendrites, Precious Stones, and several other curiosities. Collected with much trouble and expense during a series of years, and left by the late (Mr.) Albertus Seba, Member of the Imperial Leopoldic Carolinic and the Royal English Society of Sciences, as well as of the Academy of Bologna. The which will be sold by the brokers Th. Sluyter, J. Schut and N. Blinkvliet on Friday the 14th of April, 1752 and following days in the morning at 9 and in the afternoon at 3 o'clock in Amsterdam, at the house of Huybert de Wit, Landlord of the Oudezijds Grand Hotel. Everything being on preview on Wednesday preceding the Auction. The Catalogue can be obtained from the aforesaid Brokers.

The mention of Ruysch (Professor Frederic Ruysch 1638–1731, who invented a method of preserving anatomical objects in their natural colour and lustre) does not mean that part of his collection was included in the sale. The second cabinet of Ruysch was catalogued in 1731 and sold to the King of Poland for 20,000 guilders. It only meant that Seba possessed a collection of Ruysch's anatomical preparations.

Our specimen of Seba's catalogue is interleaved with blank pages on which the names of the buyers and the prices of each item have been written. The additional sum and the total amount are written on the printed pages. On the reverse side of the title page the amateurs (Heeren Liefhebbers) are informed that the table and the number under which the insects have been drawn in Seba's *Thesaurus* have been inserted in this catalogue in order to save time and space. It is promised that the remaining volumes of the *Thesaurus* will be published as soon as possible. As mentioned above this occurred in 1758 and 1765.

The first part of the catalogue, contains "Diverse Hoorns en Schulpen" (Various shells and bivalve shells) in 144 drawers (pp. 1–47). Some sea-urchins and sea-stars are included in this part. Within each drawer the items are numbered. Drawer 144 numbers unexpectedly from 144–212 and contains some corals besides the shells.



(1)

Diverſe
HOORNS en SCHULPEN.

Lade 1.

N.1 — 2 oragne Lazerusklappen.
2 — 2 dito.
3 — 3 diverſe dito.
4 — 3 dito.
5 — 3 dito.
6 — 3 dito.
7 — 3 dito.
8 — 3 dito.
9 — 3 dito.

Lade 2.

1 { Een Rots met een oragne Lazerusklap.
Een dito op Coraal.
Een dito en een Hanekam op een Rots.
2 { Een oragne Lazerusklap op een Rots.
Een dito.
Een purpere dito.
3 { Een oragne Lazerusklap op een Rots.
Een dito.
Een purpere dito.
4 { Een oragne Lazerusklap op een Rots.
Een dito.
Een bonte dito.
Twee dito.
5 { Twee Lazerusklappen aan malkander.
Twee dito.
6 { Een Lazerusklap in een Schulp.
Een dito.
7 — 4 Foely Dubletten.
8 — 4 dito.
9 — 4 dito.

A Lade

Figure 2
The first page of the Catalogue and facing page, giving the names of the purchasers and the prices

On pp. 47–49 some "Zee–Heesters etc" (Sea–shrubs, etc.) and corals numbered 1–72 are mentioned, and on pp. 49–51 "Petrifacta" (fossils).

Some prices may be quoted: two "oragne Lazerusklappen" (*Spondylus* spec.) are paid with 40–47 guilders, three ditto 13–60 guilders, a banded Spondylus ("gebandeerde Lazerusklap") 52 guilders, a "dubbelde hanekam" (*Ostrea crista–galli*) 38 guilders, a "dubbelde spinnekop" (*Murex tenuispinus*) 62 guilders, two opened mother of pearl *Trochus* shells ("Bagijnedrollen") 10–20 guilders, 8 ditto 7 guilders. Prices depend on the species and their state of preservation. For two sea-urchins with the spines on the shell 5 to 40 guilders were paid. The Nautilus-shells engraved by the well-known artist "Belkin" (Bellekin) (van Seters 1958), with the history of Esopus and pictures of biblical or historical scenes are paid with 150 – 15 guilders; other shells carved by the same artist were sold for 120–5 guilders.

A drawer full of smaller shells ("speculatiegoed") brought in 19 guilders, a branch of coral weighing two ounces 30 guilders, another of 6½ ounces 80 guilders, one of 17 ounces 120 guilders .Vosmaer bought a branch of 1 ounce for 8 guilders, two other pieces for 10 guilders, a branched Ophiuran ("Medusaas Hooft") for 58 guilders and a piece of petrified wood for 25 guilders. This first "cabinet" brought in a total of 14,873 guilders and 5 pennies. Many sometimes precious shells were bought by "Lionet" (the well-known P. Lyonet, 1706–89).

The next pages (1–38) contain: a cabinet of various excellent minerals and sediments ("Een Kabinet van diverse uitmuntende Mineralen en Droezen") (pp. 1–17), which brought in 2,336 guilders; "Een Cabinet diverse Agaten, Boomsteenen en andere Rariteiten" (A cabinet of various Agates, Dendrites and other Curiosities), among which are snuff-boxes, mortars, hilts, handles, sculptures, bowls, etc. made of agate and other stones, of tortoise-shell, mother of pearl, ivory, metal, etc. (pp. 18–28). A painting of the "dragon" with 7 heads, found in Volume I of Seba's Thesaurus was bought for 4 guilders and 10 pennies.

Pages 28–29 display a collection of fossils and of various curiosities made of amber, and pages 30–35 show various animals for which some prices may be cited: birds of paradise 8–20 guilders; (Vosmaer paid 11 guilders 10 pennies for two of them), armadillos 10–20 guilders; twelve swords of sword-fishes 5 guilders; a collection of various lizards 11 guilders; of bezoar-stones 71 guilders.The total value of the items listed on pages 18–35 was 2,540 guilders. Pages 25–37 display anatomical preparations made by Professor Ruysch. A small skeleton in a case is paid with 31 guilders; a skull, 10 guilders; a child's head, injected, showing the cavities of the brain, 17–61 guilders; the injected foot of a newly-born child, 15 guilders; an embryo with placenta and an anatomised penis, 26 guilders 10 pennies; embryos, 13–21 guilders. This anatomical collection yielded 564 guilders and 5 pennies. To this are added (p. 38) ten various cabinets and cases for storing shells, etc. The most elaborate, made of walnut, sold for 380 guilders; the others yielded 10–76 guilders, the total amount being 1207 guilders and 15 pennies.

The next section, (pp. 1–18), is a "Catalogus van diverse rare en uitmuntende

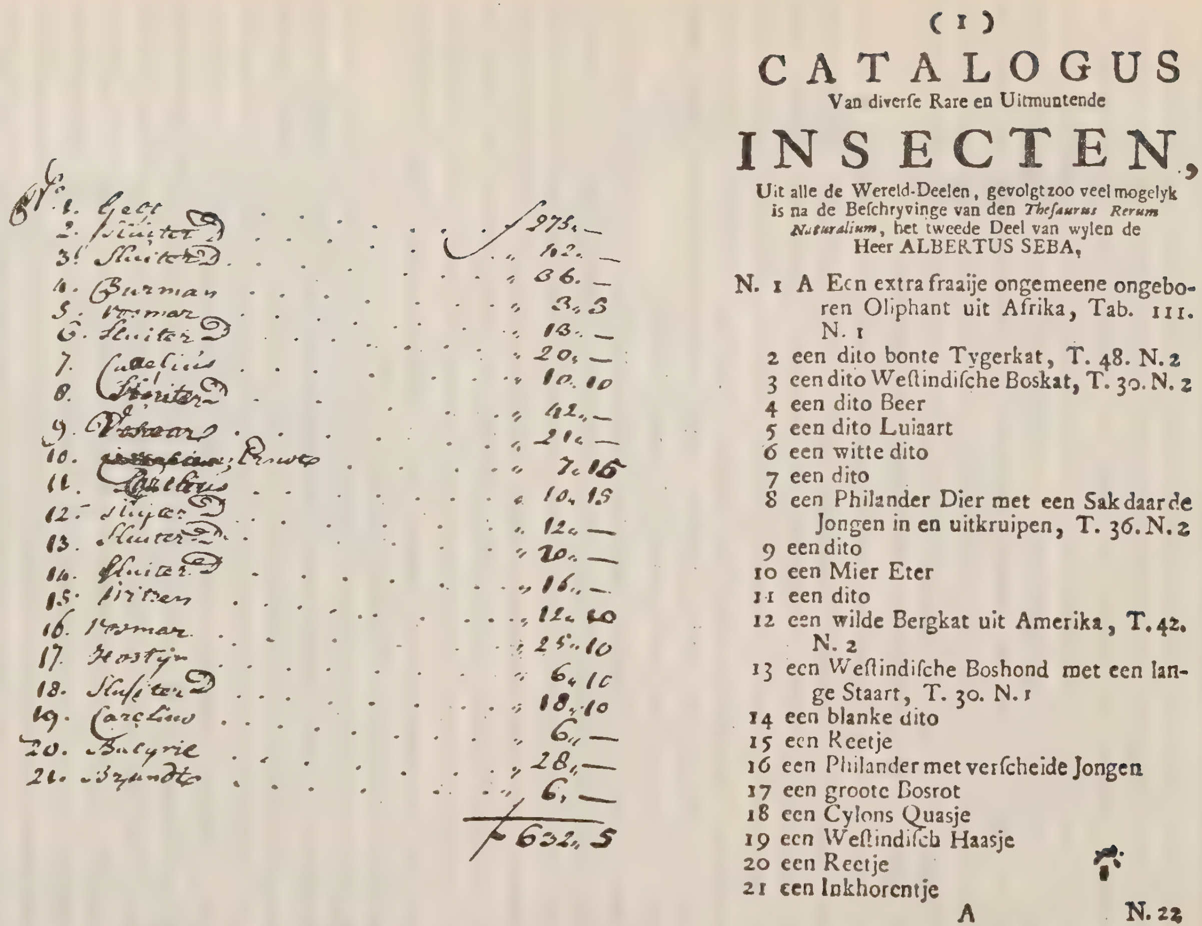


Figure 3

The first page of the third part of the Catalogue with facing page, giving the names of the purchasers and the prices

Insecten, uit alle de Wereld-Deelen, gevolgt zoo veel mogelijk is na de Beschrijvinge van den Thesaurus Rerum Naturalium, het eeмde Deel van wijlen de Heer Albertus Seba", (Catalogue of various curious and extcellent insects, form all parts of the world, following as far as possible the description of the Thesaurus, second part of the late Albert Seba). This is wrong since these animals are not drawn in the second but in the first volume of the Thesaurus. It begins with the well-known embryo of an elephant, drawn in Seba's Thesaurus I Tab. III Fig. 1 (Lönnberg 1904) which was bought for 275 guilders by a Mr. Gelt. The embryo of a tigercat (Tab. 48, Fig. 2) yielded 42 guilders, that of a West Indian wild cat (Tab. 30, Fig. 2) 36 guilders, the Philander with its young creeping in and out of the pouch (Tab. 36 Fig. 2) was sold for 42 guilders, the Siamese Haoan Devil of the island of Formosa (Tab. 53, Fig. 5) yielded 31 guilders 10 pennies, a flying squirrel from Virginia (Tab. 44 Fig. 3) 14 guilders and 10 pennies, Pipas were sold for 7 to 13 guilders, three turtles for 10 guilders and 10 pennies, an armadillo for 20 guilders, two crocodile eggs (a young is hatching from one) 19 guilders. Professor Burman, the botanist, a friend of Linnaeus, paid 5 guilders and 15 pennies for a banded lizard, a scorpion from the Cape, various fruits and a very beautiful frog. Smaller animals were thus sold together for smaller amounts. Vosmaer (see above) paid 6 guilders 10 pennies for a chameleon, a milliped, various toads, the African lizard form Guinea (Tab. 92 Fig. 4), and 6 guilders for four lizards and the Mexican Chameleon of Tab. 82, Fig. 1, and 7 guilders 5 pennies for two crested iguanas. While Burman often bought botanical objects, and also different Vertebrates and Invertebrates, Vosmaer made a judicious choice especially among: mammals, birds, lizards, fishes, shells and many lower animals. The total value of this collection was 2,433 guilders. It is curious to note that the brokers paid much higher prices than Vosmaer and Burman.

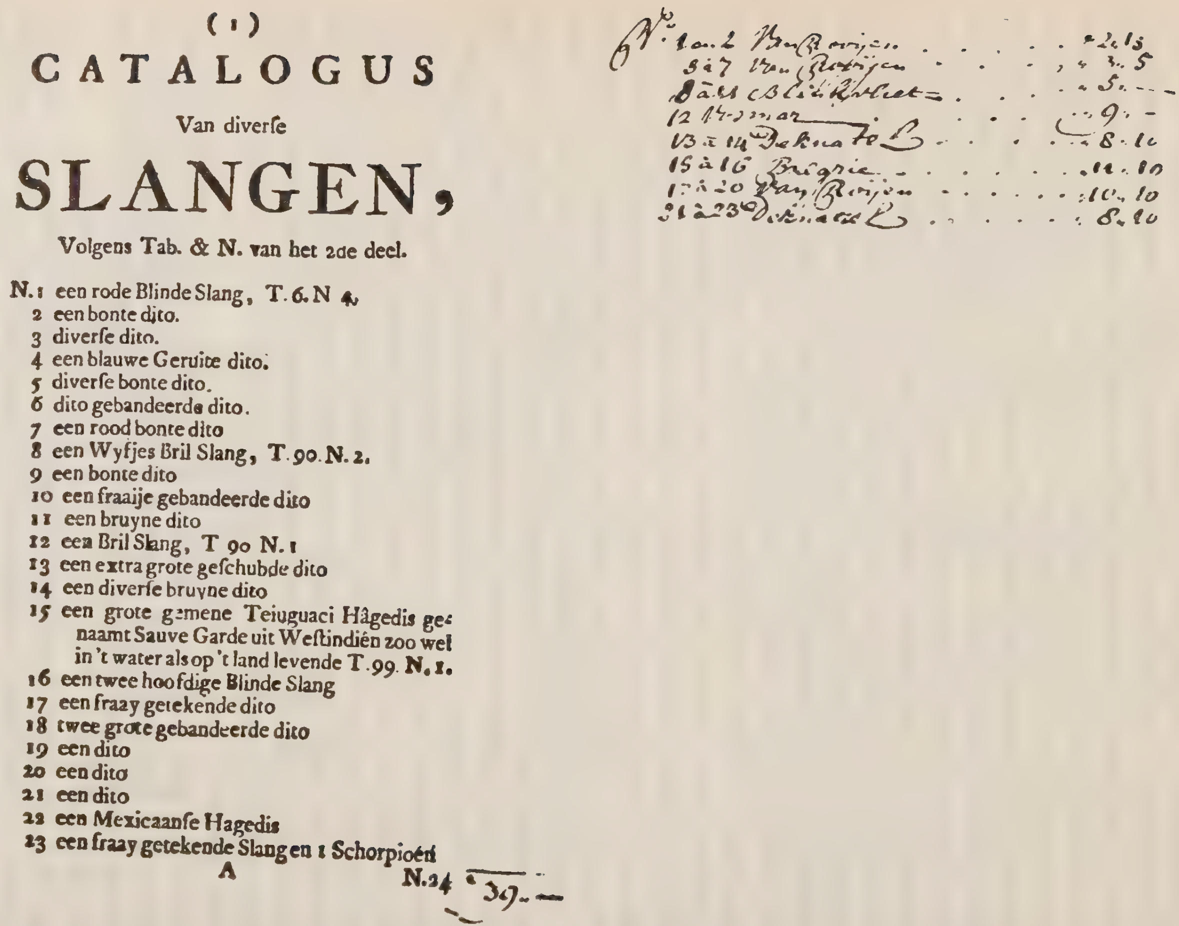
Next follows (pp. 1–13) "Catalogus van diverse Slangen, volgens Tab. en N. van het 2e deel" (Catalogue of Snakes, in accordance with table and nr. of Volume II). The collection contains mostly snakes and lizards. Vosmaer paid 9 guilders for the hooded snake of Tab. 90 Fig. 1 and bought many other snakes and lizards in groups.

Pages 14 and 15 contain birds in liquor (from Volume I), 51 numbers, of which Vosmaer bought 30 items for 60 guilders.

Pages 16–22 contain the "Catalogus van diverse Vissen in liquor" (Fishes in liquor) which did not yield high prices. Professor Burman was obviously also interested in these animals. The total cost of the snakes, birds and fishes amounted to 1,050 guilders and 15 pennies.

The whole sale yielded a total of 24,440 guilders, a considerable sum if we consider that Seba had sold his first collection for 15,000 guilders to Czar Peter, while Professor Ruysch obtained 30,000 for the Cabinet he sold to Czar Peter and 20,000 for that sold to the King of Poland.

I already mentioned Professor Johannes Burman (1707–80) and Aernout Vosmaer (1720–99) as important buyers. Many things were bought by the brokers mentioned on the title page. Often a letter is added to their name, probably indicating for



(1)

CATALOGUS

Van diverſe

SLANGEN,

Volgens Tab. & N. van het 2de deel.

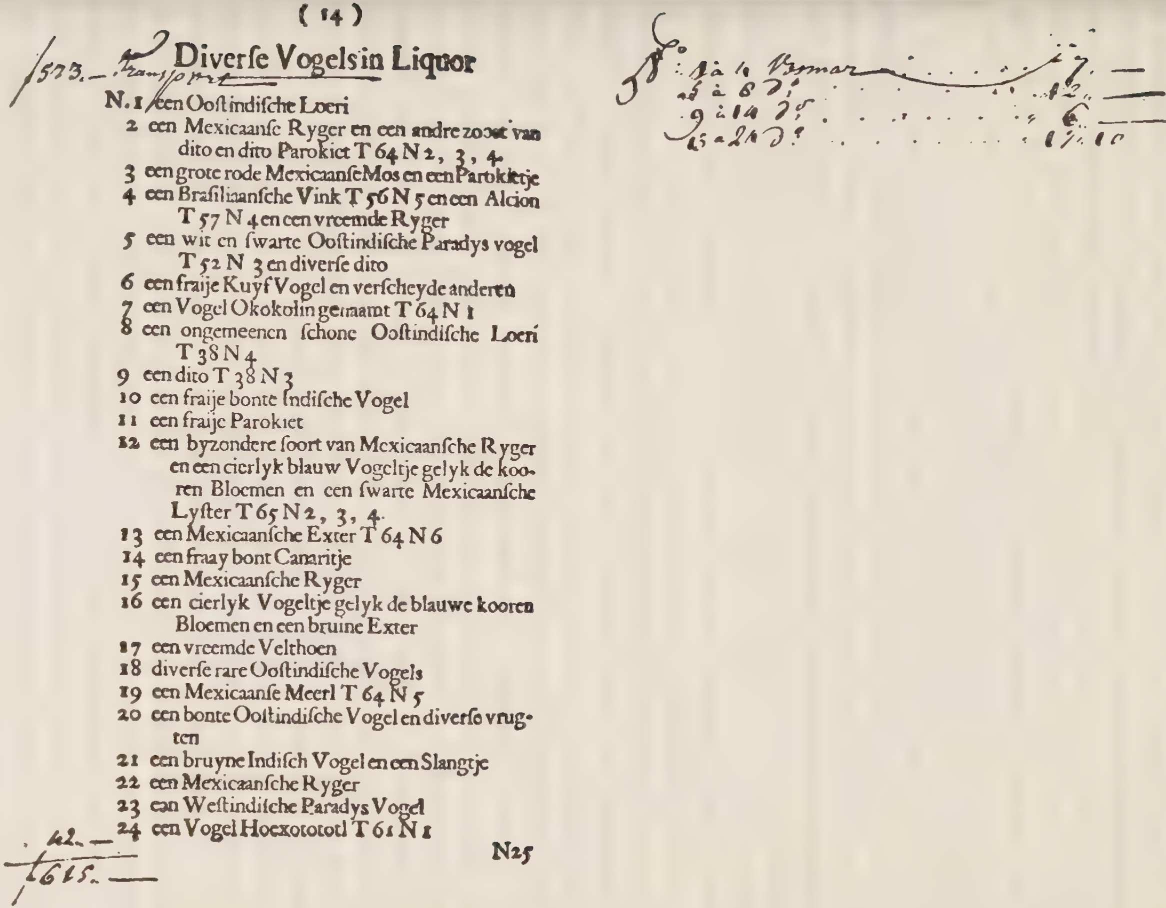
N. 1 een rode Blinde Slang, T. 6. N 4.
2 een bonte dito.
3 diverſe dito.
4 een blauwe Geruite dito.
5 diverſe bonte dito.
6 dito gebandeerde dito.
7 een rood bonte dito
8 een Wyfjes Bril Slang, T. 90. N. 2.
9 een bonte dito
10 een fraaije gebandeerde dito
11 een bruyne dito
12 een Bril Slang, T 90 N. 1
13 een extra grote geſchubde dito
14 een diverſe bruyne dito
15 een grote gemene Teiuguaci Hâgedis genaamt Sauve Garde uit Weſtindiën zoo wel in 't water als op 't land levende T. 99. N. 1.
16 een twee hoofdige Blinde Slang
17 een fraay getekende dito
18 twee grote gebandeerde dito
19 een dito
20 een dito
21 een dito
22 een Mexicaanſe Hagedis
23 een fraay getekende Slangen 1 Schorpioen

A

N. 24 39.—

No 1 en 2 Van Rooijen 2.15
3 à 7 Van Rooijen 3.5
8 à 11 Blikkenbeet . . . . . 5.—
12 Hoijman . . . . . 9.—
13 à 14 Dekker 8.10
15 à 16 Brugeie 11.10
17 à 20 Van Rooijen 10.10
21 à 23 Dekker 8.10

Figure 4
The first page of the fourth part of the Catalogue with facing page, giving the names of the purchasers and the prices



(14)

1573.– Transport

Diverſe Vogels in Liquor

N. 1 een Ooſtindiſche Loeri
2 een Mexicaanſe Ryger en een andre zoo een van dito en dito Parokiet T 64 N 2, 3, 4.
3 een grote rode MexicaanſeMos en een Parokietje
4 een Braſiliaanſche Vink T 56 N 5 en een Alcion T 57 N 4 en een vreemde Ryger
5 een wit en ſwarte Ooſtindiſche Paradys vogel T 52 N 3 en diverſe dito
6 een fraije Kuyf Vogel en verſcheyde anderen
7 een Vogel Okokolin genaamt T 64 N 1
8 een ongemeenen ſchone Ooſtindiſche Loeri T 38 N 4
9 een dito T 38 N 3
10 een fraije bonte Indiſche Vogel
11 een fraije Parokiet
12 een byzondere ſoort van Mexicaanſche Ryger en een cierlyk blauw Vogeltje gelyk de kooren Bloemen en een ſwarte Mexicaanſche Lyſter T 65 N 2, 3, 4.
13 een Mexicaanſche Exter T 64 N 6
14 een fraay bont Canaritje
15 een Mexicaanſche Ryger
16 een cierlyk Vogeltje gelyk de blauwe kooren Bloemen en een bruine Exter
17 een vreemde Velthoen
18 diverſe rare Ooſtindiſche Vogels
19 een Mexicaanſe Meerl T 64 N 5
20 een bonte Ooſtindiſche Vogel en diverſe vrugten
21 een bruyne Indiſch Vogel en een Slangtje
22 een Mexicaanſche Ryger
23 een Weſtindiſche Paradys Vogel
24 een Vogel Hoexototol T 61 N 1

N 25

42.–

1615.–

Figure 5
Page 14 of the fourth part of the Catalogue with facing page, giving the names of the purchasers and the prices

whom they were bidding at the auction. Among the buyers are many well known owners of cabinets mentioned in my "Alphabetical List of Dutch Zoological Cabinets and Menageries", (Engel 1939), e.g. J. C. Brandt (1703–91, nr. 107, p. 261), Deknatel (nr. 192, p. 267), Ernst (nr. 244, p. 271), Grenobius (i.e. J. F. Grenovius 1690–1760 or his son L. Th. 1730–77, nr, 318, p. 276 and 319, p. 277), Homoet (nr. 389, p. 282), Laars or Laarse (may be A. Leers, 1719–67, nr. 488, p. 287), Lionet (i.e. P. Lyonet 1706–89, nr. 529, p. 293), C. P. Meyer (nr. 565, p. 296), Van Mollum (probably Van Mollem, nr. 589, p. 298), Orsoy (nr. 631, p. 302), Oudaan (1702–66, nr. 634, p. 302), Van Rooyen (perhaps Professor Adrianus van Royen, 1704–79, botanist at Leyden University?), Schut (perhaps Schutte nr. 775, p. 314), Witzen (i.e. Jonas Witsen, nr. 991, p. 333).

Of course, I tried to follow some objects as they later on must have passed to other collectors, but it proved to be impossible to recognize them in the auction catalogues of these later owners as they are named above. The fact that the catalogue refers to the figures in Seba's *Thesaurus* might be of help in finding the objects somewhere.

Most probably Van Rooyen bought for Leyden University, if not for his own collection, while Vosmaer certainly bought for the Collections of the Stadtholder, His Highness the Prince of Orange, as well as for his own cabinet.

The collections of the Stadtholder were, in 1795, transferred to Paris, and therefore most probably the Paris Muséum d'Histoire Naturelle contains many of Seba's natural curiosities. For, though Professor Brugmans later on went to Paris to recover the confiscated objects, the museum authorities there managed to send him back with a "general collection". Brugmans was a "general zoologist" and had no idea of the value of special museum specimens. Therefore, the animals from Seba's collections, which are found in Dutch museums, came there through other channels.

As I mentioned in "The Life of Albert Seba" (Engel 1937, p. 83), the Russian "Kunst-Kammer" in St. Petersburg contains various additions from the 1752 auction. On p. 94 of the same paper I gave some more data and suggestions as to the probable fate of some of Seba's animals after the auction.

W. S. S. van Benthem Jutting, in the paper: "A Brief History of the Conchological Collections at the Zoological Museum of Amsterdam, with some Reflections on 18th Century Shell Cabinets and their Proprietors, on the Occasion of the Centenary of the Royal Zoological Society "Natura Artis Magistra" in: Bijdragen tot de Dierkunde, 27e aflevering, 1939, pp. 167–246, mentions some of Seba's shells that passed to other collections, viz. p. 169 a *Delphinula arion*, p. 207 *Angaria arion* (this may refer to the "curious Indian shells" of drawer 87 in our catalogue; nr. 2 was sold to Vosmaer for 36 guilders, nr. 3 and 4 to Lyonet for 7 and 7 guilders and 5 pennies, respectively).

An enumeration of the purchasers not mentioned above may be of some use: Iserel Arons, Balgrie, Beukelaar, Beun, Buk, Canouw, Carelius, Benjamin Daniels, Dynot, Dulong, Jeremias Gale, Gelt, Gourne, Haringkaspel (sic), Hasselgrein

(Hasselgrijn), Van Henouw, Hostijn, Jacob Jedeman, Lentels, Muller, Lammert van Otten, Putman, Ramalijn, Rampus, Ratlouw, Ratsouw, Rogé, Vincent Rijke, Isac Samuels, Jan de Serf (Deserf), Saantcamp (Zaantcamp, Zantcamp), Schut, Sintel, Strabbe, Tonijn, Valencijn (Valenzijn), Hendrik Vastenouw, Vrolijk (De Vrolijk), Zijdervelt.

The Catalogue is an interesting contribution to our knowledge of Albert Seba and the "naturae curiosi" of his period.

REFERENCES

1. ENGEL, H., 1937, The life of Albert Seba, *Svenska Linné Sällskapets Årsskrift*, XX, 75–100.
2. ENGEL, H., 1939, Alphabetical list of Dutch zoological cabinets and Menageries, Bijdragen tot de Dierkunde, 27e aflevering.
3. LÖNNBERG, E., 1904, Demonstration eine Fötus vom westafrikanischen Elefanten, *Ctes. Rendus du 6^{me} Congr. Int. d. Zool.*, Berne, 323.
4. VAN SETERS, W. H., 1958, Oud-Nederlandse Parelmoerkunst, het werk van leden der familie Belquin, parelmoergraveurs en schilders in de 17e eeuw, *Het Nederlands Kunsthistorisch Jaarboek* (Netherl. Year-Book for History of Art).

THE EARLY DEVELOPMENT OF THE "CAUL FLOWER" GALL

Guta Wertheim and J. Linder
Department of Parasitology, The Hebrew University–Hadassah Medical School, Jerusalem

The "cauliflower" gall has been reported from *Pistacia khinjuk* in Iran and from *P. atlantica* in Israel and Syria (Bodenheimer and Swirsky 1957, Wertheim 1954, Hille Ris Lambers 1957). The aphid responsible for the formation of this gall has been recently recognised by D. Hille Ris Lambers ((l.c.) as a new species of *Slavum*, family Fordinae. The gall (Figure 1) consists of a short cylindrical stem divided proximaly into 2–4 main branches, these in turn subdividing into short, irregular pouches. It is a hollow bag-like structure entirely closed off from the outside.

Rübsaamen (1902) considered this gall to represent a deformation of the whole inflorescence, while according to Bodenheimer (1927, p. 77) "the entire leaf is intensively deformed so that it is impossible to recognise its real character".

Wertheim (1954) observed small cylindrical outgrowths which could be seen on the resting buds of *P. atlantica* in June, and considered these to represent early stages in the formation of this gall. Recent observations revealed that these small cylinders are in fact advanced stages in the development of the "cauliflower" gall and that the gall is a result of a deformation of the leaf primordium of the axillary bud, whose ultimate fate is a protecting scale.

The sequence of events leading to gall formation is depicted in Figures 2, 3, 4. The first instar fundatrices hatching in spring from overwintering eggs (Wertheim 1954) settle on the inside of the leaf prmiordia on the axillary buds. At this time the newly developed shoot consists of compound leaves with small, green buds in the axils of the petioles. The small axillary buds are oval structures elongated in an axis parallel to the twig, and are covered with 6–10 leaf-primordia closely adhering to the appex.

The presence of the young aphids inside a leaf-primordium is indicated by the top of the leaf detaching itself slightly from the bud. The central part of the leaf begins now to thicken and a small swelling is formed (Figure 2). As this swelling increases in size, the rim of the leaf encloses the rest of the bud and unites with the apex and the adjacent leaves, so that the normal structure of the bud is lost. At this stage the insect becomes closely surrounded by plant tissue and is enclosed in a small space (Figure 3). This process of gall initiation is completed within 10–12 days.

Received September 3, 1961.

As the young gall continues to grow its walls become thinner ,and when finally the initial cylinder is formed its inside is hollow (Figure 5).

In Figures 6 and 7 two latter stages of gall development are shown in which the primary cylinder has branched and small pouches are beginning to develop at their ends. From this stage on, the gall increases till after two months of growth it attains its final size.

When the aphids first settle on the buds, about the middle of April, several insects can be seen on a single bud in the inside of the leaves. As many as 13 were counted on one bud, with 2–3 insects on one leaf primordium. After a few days, however, dead aphids can be found on many leaves, and wherever more than one settled on one leaf, only one remains while the rest die so that the gall is actually a response to the sucking of one first instar aphid.

As can be seen from Figure 8, several galls may begin to form on one bud, but only one was observed to fully develop. The additional galls are pushed aside by the most advanced one, and dry up. In the Table below results of gall count and distribution on 10 twigs picked at random are presented.

TABLE I

Gall number and their distribution on 10 twigs picked at random

Twig No.	Number of attacked buds	Number of galls	Gall distribution. Each digit represents the number of galls on a single bud.
I	6	6	1,1,1,1,1,1.
II	4	5	1,1,2,2.
III	5	6	1,1,1,1,2.
IV	4	5	1,1,1,2.
V	6	8	1,1,1,1,2,2.
VI	5	7	1,1,1,2,2.
VII	5	5	1,1,1,1,1.
VIII	2	2	1,1.
IX	5	12	2,2,2,3,3.
X	3	9	2,2,5.

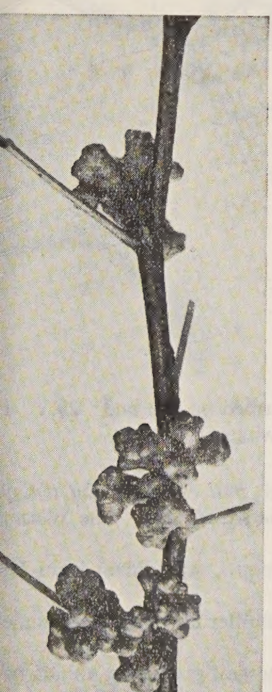
As many as 5 galls began to develop in one bud of twig no. 10, but only one could be expected to complete its development, since no two galls were ever observed to achieve full size on a single bud.

Within 3–4 weeks a normal, unattacked bud will terminate its growth, the outermost leaf primordia become brown and form protecting scales for the enclosed embryonal shoot. At the same time the remains of the leaves surrounding the gall dry up and turn brown. The gall therefore appears to be attached directly to the twig (Figure 1).

The galls in Figure 1 may appear smaller than the ones presented in previous papers (Bodenheimer 1927, Wertheim 1954, Hille Ris Lambers 1957), but what was actually shown by these authors was a cluster of galls formed on closely adjacent buds and thus appearing as a single gall.

ls consisting of initial cylinders 15.VI. 1955

Fig. 6. Young galls 29.VII. 1955



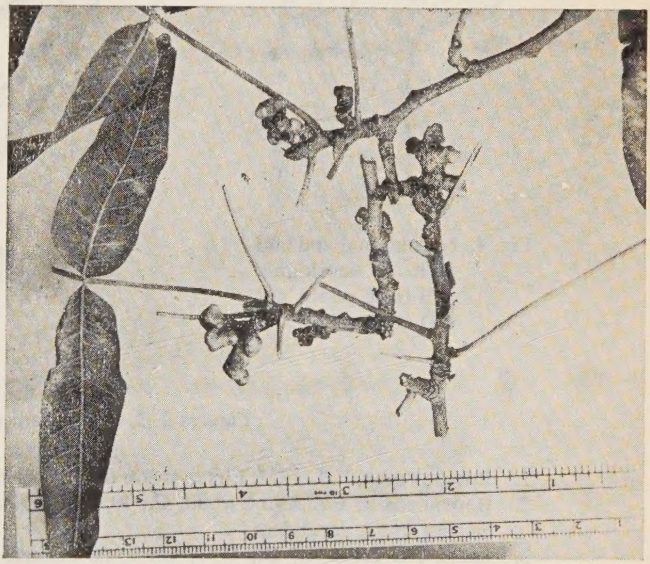


Fig. 7. Young galls, latter stage than in 6 29.VII. 1955

← Fig. 1. Three fully grown galls on *P. atlantica* on buds set apart— upper and lower side VIII .1960

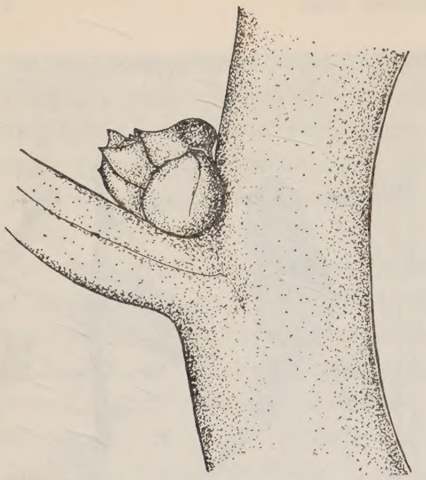


Fig. 2. Initial swelling on leaf primordium 24.IV. 1960

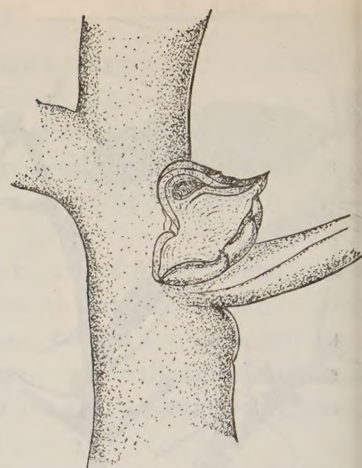


Fig. 3. Cross section of initial swelling show ing aphid chamber 3.V. 1960

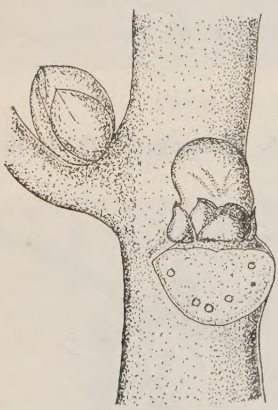


Fig. 4. Normal bud and bud with a developing gall (leaf petiol cut off) 8.V. 1960

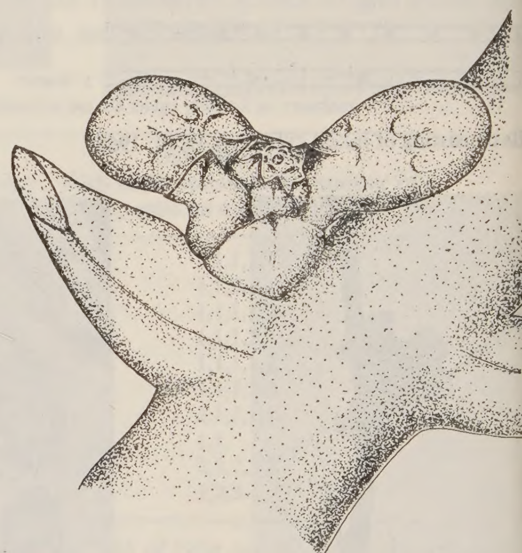


Fig. 8. Two galls formed on one bud 29.V. 19

Figures 2, 3, 4, 8 — camera lucida drawings.

REFERENCES

1. Bodenheimer, F.S., 1927, First note on the Zoocecidia of Palestine, *Bull. Soc. Roy. Ent. d'Egypt*
2. Bodenheimer, F.S. and Swirki, E., 1957, *The Aphidoidea of the Middle East*, The Weizman Science Press, Jerusalem.
3. Hille Ris Lambers, D., 1957, On some *Pistacia* aphids (Homopt., Aphididae) from Isra *Bull. Res. Counc. of Israel*, **6B**, 170-175.
4. Rubsaamen, E.H., 1902, Mitteilung über die von Herrn J. Bornmüller im Oriente gesammelt Zoocecidia, *Zool. Jahrb. Abt. Syst.*, **16**, 243-246.
5. Wertheim, G., 1954, Studies on the biology and ecology of the gall producing aphids of t tribe Fordini (Homoptera, Aphidoidea) in Israel, *Trans. R. Ent. Soc. London*, **105**, 79–96.
6. Wertheim, G., 1955, New observations on gall producing aphids on *Pistacia atlantica* in Isra *Bull. Res. Counc. of Israel*, **4**, 392–393.

יוצא לאור ע״י
מוסד ויצמן לפרסומים במדעי הטבע ובטכנולוגיה בישראל
המועצה המדעית לישראל – משרד החנוך והתרבות – האוניברסיטה העברית בירושלים

Published by
THE WEIZMANN SCIENCE PRESS OF ISRAEL
Research Council of Israel, Ministry of Education and Culture
The Hebrew University of Jerusalem, Technion—Israel Institute of Technology
The Weizmann Institute of Science, Bialik Institute

Printed in Israel

Raphael Haim Hacohen Press Ltd. Jerusalem